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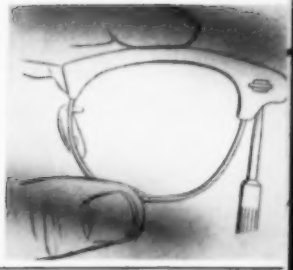

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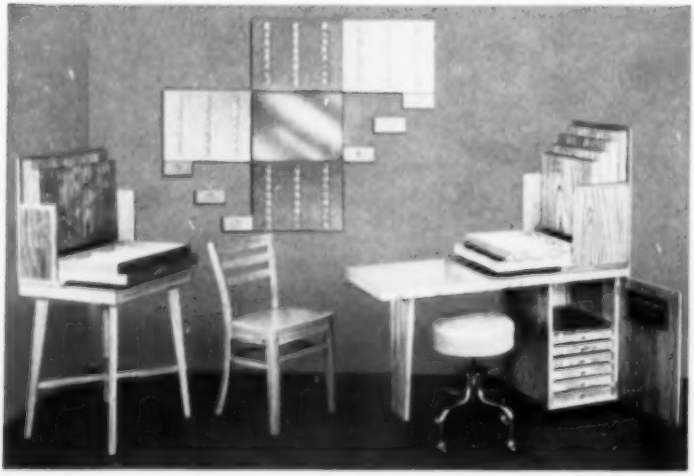

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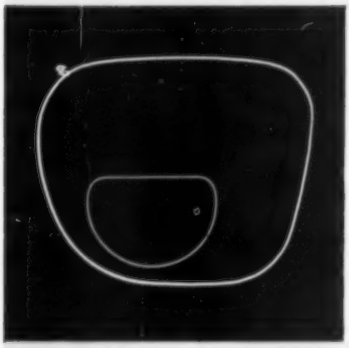

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CHEIROSCOPIC DRAWING: TARGET MODIFICATION FOR MAXIMUM TRAINING BENEFITS*

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Chicago, Illinois

INTRODUCTION

A *cheiroscope* is a plus lens stereoscope combined with a firm platform which is usually positioned at the focal plane of the lens system. Any target placed on the drawing platform of the instrument would create the optical conditions *as if* the target were located at infinity. The target platform is of sufficient size to hold a line drawing before one eye and blank paper before the other eye.

Cheiroscopic drawing serves three purposes: (1) as a visual skill test, (2) to aid in determining the prescriptible lenses or prisms, and (3) as a visual training procedure.

As a visual skill test the cheiroscope furnishes a permanent record of the presence of suppression, the magnitude and variability of lateral and vertical phorias, and the adequacy of eye and hand coordination.

As an aid in determining prescriptible lenses or prisms, the cheiroscope furnishes a permanent record of the effect of lens changes and prism changes upon convergence under the dynamic conditions present during cheiroscopic drawing. Using the same target, the patient makes one cheiroscopic tracing with his habitual lenses in place and repeats this task with the proposed lenses in place. The change in the amount of separation and stability of the drawings when compared with each other has diagnostic value. Similarly, with the hyperphoric patient we can add sufficient base-up or base-down prisms so that the tracing and the target are on the same horizontal line. Since the patient has some degree of freedom of movement, he tends to assume his normal posture when he makes his tracing of the target. This amount of vertical prism might constitute a dynamic balancing of the vertical posture of the patient.

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†Optometrist. Member of faculty. Fellow, American Academy of Optometry.

As a visual training procedure, cheiroscopic drawing is used to eliminate suppression, reduce amblyopia, improve acuity, build fusional range, change phorias toward normal, develop hand-and-eye coordination and develop a kinesthetic matching of the visual stimuli pattern.

A certain dilemma is present in cheiroscopic drawing since the use of the hands informs the patient that the target is at near while the optical system informs the visual pattern that the target is at infinity. We thus find that considerable psychic and kinesthetic convergence will result. We can minimize or exaggerate this effect to suit the purpose of the training or testing procedure. For example, in training the high exotrope or exophore it is desirable to stimulate this effect; whereas in training the high esotrope or esophore it is highly desirable to minimize this effect. If the psychic and kinesthetic convergence are not kept under proper control, the patient with a high phoria or a tropia will find it impossible to perform at this type of training. The high esophore, when proper control is not used, will tend to move his pencil on top of the picture or at best will be able to reproduce only a portion of the target (see Figure 1). The high exophore will make his tracing at such a great distance from the target that every little shift in convergence will be a cause for starting the tracing over and over again. A typical tracing made by the high exophore is shown in Figure 2.

CONTROLLING PSYCHIC AND KINESTHETIC CONVERGENCE

The following factors influence psychic and kinesthetic convergence: (1) Body posture (2) Plane of the drawing platform (3) Target and (4) Drawing technique. By proper modification, these factors can be used to stimulate or inhibit psychic and kinesthetic convergence. These principles are outlined in Table I. In order to obtain

TABLE I

FACTORS WHICH INFLUENCE THE MAGNITUDE OF PSYCHIC AND KINESTHETIC CONVERGENCE

CONTROL FACTOR	TO MINIMIZE (INHIBIT) PSYCHIC AND KINESTHETIC CONVERGENCE	TO STIMULATE PSYCHIC AND KINESTHETIC CONVERGENCE
Body posture	1. Erect posture	1. Torso bent forward
Plane of drawing platform	2. Eyes ahead	2. Eyes downward
Target	3. standing Drawing platform is erect or perpendicular to the ground	3. Seated Drawing platform down or parallel to the ground
Drawing Technique	1. Small size 2. Gross detail Patient to have pencil only in contact with paper	1. Large size 2. Fine detail Patient to rest his hand on paper as added support

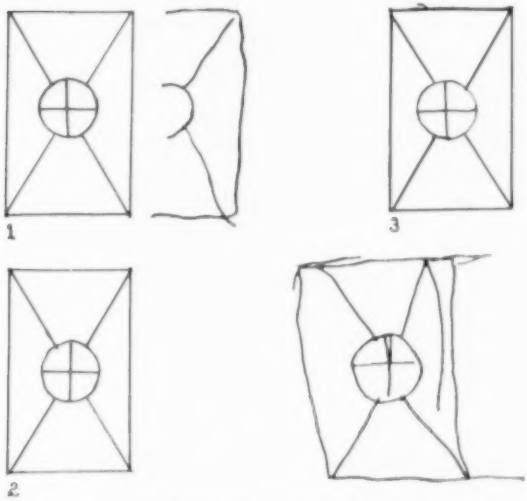

Fig. 1. Upper left. Cheiroscopic tracing made by high esophore on standard target. Fig. 2. Bottom. Tracing made by high exophore on standard target. Fig. 3. Upper right. Target for testing purposes.

the proper patient response, these factors must be used as an aid in obtaining the proper influence of psychic and kinesthetic convergence. It is the purpose of this paper to discuss target design and dimension, as an aid in utilizing psychic and kinesthetic convergence as a training aid in obtaining a patient response. Since the ability of the patient to trace a target presented in a stereoscopic device depends upon target dimension and content, it is important that the same target is always used for testing. Further, the testing target must not be used for training purposes.

CHEIROSCOPIC TARGET FOR TESTING PURPOSES

A cheiroscopic target for testing purposes should be composed of lines in several meridians and should also incorporate a number of familiar forms such as a rectangle, cross, ball and a triangle. It must be of sufficient dimension so that for the average range in lateral and vertical phorias the patient will be able to trace the target. An overall size of 37x60 mm. has been found to be most suitable. This target is reproduced in Figure 3.

CHEIROSCOPIC TARGETS FOR THE ESOPHORE

The targets used for the esophore should be about two-thirds the width of the testing target. There should be no frame outline around

the target. No detailed or elaborate targets should be used. Simple shapes such as numerals, letters of the alphabet, simple geometric forms or narrow objects in simple outline may be used as target ideas. Figure 4 presents some simple targets which are suitable for the esophore.

CHEIROSCOPIC TARGET FOR THE EXOPHORE

The target for the exophore should be larger and contain more detail. A suitable target size is 45x60 mm. All of these targets should be surrounded by a frame. A "build-a-picture" sequence may be constructed. Figure 5 presents a typical series of targets useful for the exophore.

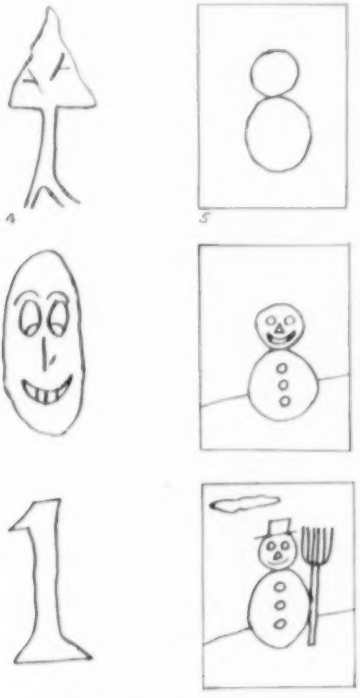

Fig. 4. Three figures at left. Targets for the esophore. Fig. 5. Three figures at right. Targets for the exophore.

CHEIROSCOPIC TARGET FOR THE ESOTROPE

The target for the esotrope must be very narrow and gross in nature. No detail can be present. The target dimension should be 10x60 mm. This rectangle is filled in with black india ink. A typical target and patient drawing of same is included in Figure 6.

6

7

Fig. 6. Left. Targets for the esotrope and typical patient tracing. Fig. 7. Right. Target for the exotrope and typical patient tracing.

CHEIROSCOPIC TARGET FOR THE EXOTROPE

One of the most effective targets for the exotrope has been a large black ball of 45 mm. diameter. The patient is instructed to place his pencil in what he thinks is the middle of the circle and to fill it in solid by making a continuous spiral with his pencil. The first spiral tracings made by the exotrope will usually have considerable distortion. As training progresses the spatial orientation of the patient improves and he can be advanced to a more difficult target such as a heavily drawn box 45x60 mm. It has been found that this training is more effective if the pencil is used on the side corresponding to the amblyopic eye.

CONCLUSION

Cheiroscopic drawing has not been used frequently because the patient had difficulty in making a tracing using the standard targets which are usually supplied with these instruments. The value of cheiroscopic drawing in breaking down suppression, reducing amblyopia, and improving fusion has been long recognized but the phoria of the patient has often made it impossible to utilize this procedure.

The presence of psychic and kinesthetic convergence can be used as an aid in order to use cheiroscopic drawing with these subjects. Using a target which is properly designed for a particular situation will speed up the advancement of the patient in performing at cheiroscopic drawing. As the stability of the patient improves the targets are changed to keep abreast of the development of the patient. Proper target design follows the basic precept — *Learning situation must be at the level of the patient.*

As Table I indicates, it is important to use the other control factors of body posture, plane of drawing platform and drawing technique as additional aids for the control of psychic and kinesthetic convergence. The learning rate of the patient is advanced when we train under conditions which allow for optimal performance.

EXPERIENCES WITH SCLERAL TONOMETRY*

Ralph E. Wick†
Rapid City, South Dakota

In 1947 the writer presented before the American Academy of Optometry a paper on Scleral Tonometry.[1] The purpose of this paper was to introduce a technique which could be adopted by optometrists to aid them in the early detection of glaucoma. The scleral tonometer had been used in our office for about two years prior to the presentation of the paper. This now gives the writer a ten year period in which to evaluate his experiences with this technique.

Every attempt has been made to avoid excessive enthusiasm for this procedure. This is not too difficult because of the defects inherent in tonometry in general. Scleral tonometry has several disadvantages. First, it can be used only with an anesthetic on some patients because of the sensitive area on which it is applied. Second, occasional undependable readings are obtained. Third, it is possible to injure the sclera. Fourth, it is not always as accurate as is corneal tonometry. These four objections to scleral tonometry were serious enough that they have constituted a challenge to the validity of the findings obtained by this instrument. It is the writer's opinion that he now has reasonable answers to most of the objections which have been raised against the use of the scleral tonometer.

There are a few patients on whom the scleral tonometer can be used only with an anesthetic. There are even some patients on whom a good external examination cannot be performed. These "nervous" or "sensitive" people require extreme care and a calm assured attitude on the part of the examiner. The position of the patient on whom scleral tonometry is to be performed is of the utmost importance.[2] The necessity of a fixation target is also emphasized along with the position of the patient.[2] The instructions to the patient at this point are extremely important. It is best to tell the patient that he will feel the instrument touch his eye. It is best not to state that it will not hurt. The patient should be told to stare at the fixation target and try not to blink. If this point is stressed sufficiently it helps to take his mind off the mechanics of the test. Firmness and a steady insistance on the necessity of the test helps on some patients. Praise helps others. Warm-

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 12, 1955. For publication in the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist. Fellow, American Academy of Optometry.

ing the tip of the tonometer to body temperature helps to avoid flinching on the part of the patient from the initial contact with the instrument. Sometimes it is necessary to take one reading and to allow the patient to rest for a few minutes before taking the other two readings. It is, of course, essential to always take three readings each time before recording the results.

The problem of the occasional undependable reading is also one which is generally due to faulty technique. Careful observation of the sclera before starting the test is essential. An area with any sign of pterygium or even slight thickening of the scleral area should be avoided. The instrument should be moved just slightly for each reading to avoid taking the tension in exactly the same spot. Tipping of the instrument is probably the most difficult error to learn to avoid in this technique. The tonometer must approach the eyeball at right angles and not be tipped in the slightest from a perpendicular position. When any one of the three readings is more than 5 mm. Hg. from the other readings it should be repeated in a different spot on the sclera and the plunger should be closely examined. Sometimes a small piece of dried mucuous can adhere to the tip of the plunger and influence a subsequent reading.

In spite of all precautions an undependable average reading will be obtained at times. All optometrists with some years of practice have encountered experiences with their retinoscopes which are unexplainable. The isolated instances in which large differences occur between the retinoscope and subjective findings surely do not discourage the average practitioner. Undependable readings which are occasionally encountered in scleral tonometry are similar. If the tonometer is considered as only one of the tools needed to assist in making a tentative diagnosis of glaucoma it has served its purpose.

Contrary to the belief expressed by some optometrists there is little danger of injuring the sclera if the tonometer is used properly. In the last ten years on several hundred patients there have been only two subconjunctival hemorrhages that have occurred in my office. These were not serious and both cleared in a short time. Care must be used in placing the instrument in an area which is free from blood vessels. The supplying of a definite fixation target is again emphasized as an important point in the technique. The lids must be held open on the eye being checked so that they do not sweep across the eyeball and push the plunger into the conjunctiva. Attention to these details will eliminate the possibility of serious injury.

The problem of accuracy in scleral tonometry is one which could well constitute an entire paper by itself. In 1951 the writer summed

up the real purpose of scleral tonometry as follows:

> Let us recognize that no one simple way exists to diagnose early glaucoma. Ophthalmoscopy, perimetry, tonometry and symptomatology must each have an indispensable part in making the diagnosis. The reliance on any one method is doomed to failure. It is only by carefully weighing the evidence presented in all of these four factors that an intelligent referral to an ophthalmologist can be made. Gonioscopy is another valuable method, but actually is practical for very few optometrists. Flicker fusion tests present some hopes for the future, but these are not sufficiently standardized for differential diagnosis. Evidence is accumulating, however, to the effect that a depression in the flicker fusion rate occurs early and may be present even before visual field changes.[3]

It is not necessary that accuracy to within one or two millimeters of mercury be expected from this technique. First of all it is only one of the means we should use in making a tentative diagnosis. Most important, of course, is the fact that the purpose of these tests is to determine if any indication of glaucoma is present. In the event of the slightest doubt the patient must be referred to an ophthalmologist at once. The evidence is accumulating from office experience that scleral tonometry is accurate enough to assist optometrists in making more intelligent referrals to ophthalmologists. Hirsch[4] conducted a study on the evaluation of scleral tonometry. He reported on 76 consecutive patients in an optometric practice. The study concerned the reliability, validity and clinical applicability of scleral tonometry. His conclusions so closely parallel my experiences with this technique that I would like to summarize them for you. In addition to this, some of his experiences have served to modify my own technique and deserve special comment. Hirsch states that:

> Perhaps the greatest argument against the validity of scleral tonometry is to be found in the distribution curve. This, as has already been stated, is bimodal, a condition not descriptive of intraocular tension. It must be concluded that scleral tonometry is affected by some factor other than and in addition to the intraocular pressure. The hypothesis has been advanced that this factor is the degree of rigidity of the sclera. If this is the case, then between 15 and 20 per cent of the population has scleral rigidity of such degree as to lead to unduly high scleral tonometry readings.

This observation could also account for the occasional undependable average reading obtained on some patients. A few times I have referred patients mainly on the basis of a high scleral tension only to have the ophthalmologist state that these readings could not be substantiated by corneal tension readings. There were, of course, other symptoms present to warrant the referral. Evidence was present either in ophthalmoscopy, symptomatology, visual fields or all three in addition to tonometry.

Hirsch's point that the scleral tonometer cannot be used in the same manner that the corneal tonometer is used, i.e., with a single point of demarcation (say 26 mm. Hg.) differentiating abnormal from normal is also well taken. He says:

In scleral tonometry, patients must be divided into three categories, namely: (1) those with normal pressure (readings below 25 mm. Hg.); (2) those with abnormally high pressure (readings above 30 or 32 mm. Hg.); and (3) those who have either high intraocular pressure or undue scleral rigidity (readings between 25 mm. Hg. and 30 mm. Hg.). Unfortunately, a good segment of the population (15 to 20 per cent) fall in this third group. Furthermore, it is often in this group that a differential diagnosis is so important.

It is here then that professional judgment must be exercised. The other factors mentioned previously should be carefully analysed along with tonometry, keeping in mind the weaknesses in this technique.

Hirsch also states that scleral tonometry does furnish an estimate of the intraocular pressure; that the results are of the same order of magnitude as those obtained by corneal tonometry in so far as means and dispersion are concerned; that the values of scleral tonometry are about the same as those of corneal tonometry as far as age, sex, laterality and refraction. I have found these observations to be true in the majority of instances where there has been an opportunity to compare scleral readings with corneal readings.

Some other pertinent observations made by Hirsch include such points as the value of taking three readings but averaging the last two; the technique of scleral tonometry is simple, rapid, and not costly, and that the chief value of the instrument probably lies in its use on the same patient at different times of the day.

The necessity of taking at least three readings became obvious to me early in my experiences with tonometry. The necessity of taking more than one reading was emphasized most forcibly in cases where a high reading was obtained initially and could not be repeated by taking subsequent readings. Usually in cases just mentioned I averaged all three readings. Observation, though, substantiates the fact that the last two readings were usually more alike.

The simplicity of scleral tonometry coupled with the rapidity with which it can be performed surely justifies its use if any one of the other diagnostic tests give any indication of glaucoma.

SUMMARY AND CONCLUSIONS

A ten year experience with scleral tonometry has brought out certain objections to the technique as a valid test to aid in the detection of glaucoma. Two of the objections are that it cannot be used on some patients because of the sensitive part to which it is applied, and second that occasional undependable readings are encountered. These two objections were answered by the outline of things to observe and practice in the technique of application such as the position of the patient, the necessity of a good fixation target, the instructions to the patient, attitude of the examiner and hyper-sensitivity of a few ex-

tremely nervous patients. Other points to watch concerned the proper placing of the instrument on the sclera, the angle of the tonometer, and the repeating of readings at least three times.

It was stressed that ophthalmoscopy, perimetry, tonometry and symptomatology each have an indispensable part in making the diagnosis for an intelligent referral.

It was emphasized that accuracy to within a couple of mm. of mercury was not necessary to make this technique of value.

Hirsch's research on the reliability, validity and clinical applicability of scleral tonometry was reviewed. Particular mention was made of the points he considered significant on normals and the bimodal curve he found in analyzing his distribution curve data. His preliminary research substantiated quite closely my clinical experience regarding the necessity of taking three readings and averaging the last two, the simplicity of the technique, and that the instrument must be used as a clinical tool only and must not be depended upon as an absolute screening device for glaucoma.

Scleral tonometry and corneal tonometry differ from each other in many ways. The techniques of application differ from one another; the normals are different; the interpretation of the findings are not entirely alike; the reasons for performing the tests are not always the same. In fact scleral tonometry should be considered as a technique unto itself and developed in that manner.

It is hoped that further research can be stimulated into the various aspects of scleral tonometry. Preliminary investigations and personal experiences indicate that with all the defects inherent in any system of tonometry this technique can be of value in making more intelligent early referrals of patients with suspected glaucoma.

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VISUAL REQUIREMENTS FOR RAILROAD EMPLOYEES*

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A large number of railroad workers are patients of optometrists. For years these railroad employees have had their eye examinations and refractions made by optometrists and with the glasses they have received have passed their required periodic visual screening tests. This report has been prepared to review both these standards required by management of these railroad workers, and the general position of the Association of American Railroads towards the subject of vision and eye care. Knowledge of these standards will enable optometrists to do a better refractive job for these patients. The report may also stimulate some optometrists to apply to do the necessary periodic visual screening tests as these are required of employees on re-examination and to also screen the visual acuity and color vision for new applicants for railroad employment.

While the number of optometrists doing visual screening of employees for railroads is not large, certain optometrists have done this work for years. This visual screening is properly a part of Industrial or Occupational Optometry, but differs from some forms of industrial eye care in that many of the railroad employees screened are seen at the offices of the optometrists. Others, to be sure, have their periodic screening tests made in traveling examining cars, while these are on a siding. A physician is then in charge and complete physical examinations are given. Another large number of railroad employees have these periodic tests made by general practitioners whose offices are located in various cities and towns along the line. These general practitioners do all the health testing including visual acuity, color vision and hearing. In large urban centers ophthalmologists are frequently used to make the required visual screening tests.

In general, railroad visual requirements for employees are uniform throughout the country and are based upon standards adopted by the

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Association of American Railroads, which includes all the major lines and thousands of smaller ones. Despite this general standardization, Union Contracts with individual lines may somewhat vary the schedules of periods for visual screening for employees in the different work classifications. On the other hand, the visual standards required of employees in the separate classifications remain quite constant the country over, from one railroad line to another.

In the larger urban centers and particularly in those cities which are home office railroad towns or major division points, much of the current railroad screening is done by ophthalmologists who are appointed to these posts. This is largely true for several reasons. One is that these ophthalmologists are well known to the medical director of the line, if the road is large enough to have a medical director. Another is, that it is now more or less tradition to do this and for the larger lines, physicians set up the rules and make the appointments. In addition, optometrists have been reluctant to apply for this work.

It should be pointed out that from the standpoint of management among the Association of American Railroads, this work may be done by any capable examiner. In fact, in many instances management is now seeking competent and efficient assistance. This is not only true regarding visual screening but also regarding the initial physical examination which must be taken by the prospective employee and by the regular employees at stated intervals and at certain age levels.

At the smaller (from a population standpoint) division points, and in the smaller towns and cities along the line, most railroad companies need competent examiners to serve them and their employees. They are seeking examiners who understand the requirements and who will supply management with the needed professional screening service. For those interested in this work, particularly in the smaller town areas, optometrists who apply will find they have an opportunity for service.

It must be understood that a railroad company has employees scattered all along its route. Its workers are not all concentrated in certain places and therefore railroad companies must rely upon many examiners to do the screening tests and give the physical examinations in their own offices on a modest fee basis. The fees for this work are paid by the company.

The visual screening procedures that follow in this report are minimum procedures. The examiner who makes these visual tests must fully understand the requirements of each job classification and if he is thorough in his work he will do more than merely record the uncorrected and corrected, monocular and binocular distant and near visual

acuties, as well as the findings of the color vision test. To do nothing else would leave an important part of the examiners work undone. The examiner must also keep accurate records of every screening test. In addition, he must make out periodic home office reports and must be prepared to submit his records at hearings in courts during lawsuits, as these records are the only evidence of an employee's visual acuity and eye condition made prior to a disputed claim against the company.

At this point it may be well to review certain facts relating to vision, eye hygiene, and safety as these relate to the railroad company and to the railroad worker. Since railroading would be hazardous in the hands of employees with sub-standard vision, visual tests are required of employees as a public safeguard. In addition, there are possibilities of eye injuries in railroad work, particularly in the way of getting foreign particles in the eye. Finally, railroad companies must protect themselves against various types of lawsuits brought against the company by employees who claim that an eye injury has reduced visual acuity. It is at this latter point that accurate and permanent records in the hands of the examiner are so necessary. With these on hand, the facts regarding the visual acuity under question are clear, at least at the date of the last screening.

The following are the visual requirements as outlined for each category or classification of worker by the Association of American Railroads. This material is condensed from Circular No. M&S—300 of the Medical and Surgical Section of the Association, as revised in December, 1951. These visual requirements must be met by the applicant for employment, as well as by specified employees. These requirements should be understood by all optometrists as it will aid them in correcting the visual problems of these workers in their practices. The frequency of visual screening may vary slightly from one railroad to another, but as a rule these will be found to be very similar.

GENERAL REQUIREMENTS

Applicants for employment in connection with the handling of engines, trains, or marine equipment as enumerated below, and also applicants for such other positions as may be designated from time to time by the railroad management, must pass a satisfactory physical examination before entering service, including sight and hearing. Applicants for positions in train service, and all other employees who, by reason of their occupation, are required to interpret color signals, must also pass a satisfactory examination on colors.

VISION—DISTANCE AND NEAR-POINT REQUIREMENTS

Class A. This group includes employees with the following

duties. Enginemen, Firemen, Motormen, Motormen's Helpers, Conductors, Train Flagmen, Train Baggagemen, Switchmen, Brakemen, Train Porters and all others who have any duties in connection with the operation of trains. For *entrance* to service, Class A applicants must have visual acuity of 20/20 in each eye tested separately without glasses and must have binocular single vision. For near vision the applicant must read print in paragraph No. 3 of the A.A.R. Standard Reading Card, or its equivalent, without glasses. For *promotion* while in service, Class A employees must have 20/20 in one eye and not less than 20/30 in the other, with or without glasses, and must have binocular single vision. For near vision the employee must read print in paragraph No. 3 of the A.A.R. Standard Reading Chart, or its equivalent, with or without glasses. For *Re-Examination* of those in service, the Class A employee must have 20/30 in one eye and not less than 20/40 in the other, with or without glasses, and must have binocular single vision. For near vision the employee must read print in paragraph No. 3 of the A.A.R. Standard Reading Chart, or its equivalent, with or without glasses. If the employee in Class A on examination for promotion or on re-examination is found to have a visual acuity of 20/70 or less in each eye without glasses, even though his vision can be brought up to the standard set forth by glasses, the employee must be examined by an eye man designated by the company, for recommendations as to whether or not his vision will interfere with the performance of his duties or with the safety of himself or others.

Class B. This group includes railroad employees with the following duties. Signal Repairmen, Lampmen, Yardmasters, Carpenters on line work, Hostlers, Station Baggagemen, Railroad Crossing Watchmen, Bridge Watchmen, Wreck Foremen, Track Foremen, Messengers whose duties involve danger from moving trains, Chauffeurs, Derrick Engineers, Crane Operators, Train Dispatchers, Switch Tenders, Interlocker Levermen, Telegraph Operators, Student Operators and all other employees whose duties may involve the reading or display of signals in connection with the operation of trains. For the Marine Service, Class B includes Captains, Mates, Pilots, Quartermasters, Bridge Foremen, Bridgemen, Bridge Motormen, Bridge Engineers and Firemen. For *entrance* to service, Class B applicants must have visual acuity of 20/20 in one eye and not less than 20/40 in the other, with or without glasses and must have binocular single vision. For near vision the applicant must read print in paragraph No. 3 of the A.A.R. Standard Reading Card, or its equivalent, with or without glasses. For *Re-Examination* of those in service, the Class B employee must have 20/40 in

one eye and not less than 20/50 in the other, with or without glasses, and must have binocular single vision. For near vision the employee must read print in paragraph No. 4 of the A.A.R. Standard Reading Chart, or its equivalent, with or without glasses.

Class C. This group includes railroad employees with the following duties: Car and Engine Inspectors, Ashpitmen, Air Brake and Steam Heat Inspectors, Weighmasters, Car Repairmen, Street Crossing Watchmen, Police Lieutenants, Patrolmen, Yard Clerks, Station Agents, Clerks to Station Agents, Baggage Agents, Ticket Examiners, Ushers, Telegraph Repairmen and all other applicants and employees not mentioned in Class A and Class B. For *entrance* to service, Class C applicants must have visual acuity of 20/30 in one eye and not less than 20/40 in the other, with or without glasses. For near vision the applicant must read print in paragraph No. 3 of the A.A.R. Standard Reading Card, or its equivalent, with or without glasses. For *Re-Examination* of those in service, the Class C employee must have 20/40 in one eye and not less than 20/50 in the other, with or without glasses. For near vision the employee must read print in paragraph No. 5 of the A.A.R. Standard Reading Chart, or its equivalent, with or without glasses.

TESTING PROCEDURE

Distance Visual Acuity. Any generally accepted method of testing the visual acuity will be satisfactory. The results should be recorded in fractions, the numerator being the distance in feet at which the examinee is placed from the chart (usually 20 feet), and the denominator, the line of letters read by the examinee. Mistakes of not more than three letters on the 20/20 line, two letters on the 20/30 line and one letter on the 20/40 line will be considered satisfactory. The examinor should indicate by —3, —2 or —1 after the denominator the number of letters missed, if any. Examiners should prevent applicants from memorizing the letters and the test should be made under proper illumination.

Near-point Visual Acuity. A near-point reading test card should be used. The Association of American Railroads provides such card, and suggests that the applicant or employee be required to read the card held at 14 inches, the smallest type possible and that this finding be recorded. The test should be made in good illumination. Each eye should be tested separately and then both eyes together.

Color Vision. For this test, color plate tests are suggested, or the Holmgren yarn test may be used. If color plates are used, the Ishihara, American Optical Company, or the Dvorine tests are accurate. The

findings of these color tests are most accurate when made in daylight.

GENERAL RULES

Employees engaged in engine, train, or signal service, including train dispatchers, and such others as may be designated from time to time by the railroad management, must pass a satisfactory physical examination or re-examination, including an examination of sight, color vision and hearing,* at least every two years or at more frequent intervals if required by law or otherwise. It is recommended that employees aged 50 to 65 be examined every year and those over 65 every six months.

Before an employee is permanently relieved from his regular duty or his occupation changed as a result of periodical examination, his case shall be reviewed by the Chief Medical Officer or his representative. Employees who have been disabled by reason of accident or disease, or whose sight, color sense or hearing may have become affected, must pass a satisfactory examination before resuming duty. Applicants for employment in positions requiring examination of sight, color sense and hearing should first undergo these examinations, and in the case of failure, the physical examination need not be made.

In order to prevent undue hardship to an employee in service, and recognizing the increased value of such employee because of his experience and familiarity with duties to be performed, the causes for rejection as previously outlined, shall not apply in cases of employees up for re-examination, except in so far as the disabilities found on re-examination are such as to interfere with the proper performance of his duties, or with the safety of himself or others. An employee whose vision in one eye falls below the required standard (for example, loss of vision in one eye) shall have a special examination by an eye man designated by the company. The management shall then determine whether the employee can be provided with employment where his services will not produce an extra hazardous condition.

Strabismus usually is associated with partial loss of vision in one of the eyes, or an alternating vision from one eye to the other. A person so afflicted is in the same category as the one-eyed person. There is a lack of muscle balance and depth perception. Engineers and Firemen so afflicted should be limited to services which can be performed safely and satisfactorily.

*Candidate for employment in train service should not be accepted unless able to hear ordinary conversation, with each ear separately, the full distance of 20 feet. Candidates for promotion or re-examination should pass this test at no less than 10 feet. The use of hearing aids is not recommended.

A cataract in one eye reduces or destroys the vision in that eye. After operation on one eye the refraction of the two eyes is different, which causes defective vision and the judgment of distance is poor. Post-operative vision, corrected or uncorrected, is usually poor and judgment of distance is impaired. Engine and train service men with cataract, whether operated on or not, should be limited to services which they can perform safely and satisfactorily. This applies to engine and train service men with bilateral cataracts, whether operated on or not.

Employees whose vision requires the use of glasses to meet the standards and whose duties necessitate the reading of signal indications must, while on duty, wear such glasses. Employees requiring glasses for distant vision must have with them, while on duty, two pairs of the required glasses. Where glasses are required for both distant vision and reading, two pairs of distant spectacles and one pair of reading glasses or two pairs of bifocal spectacles must be carried. Where glasses are necessary for reading only, one pair of spectacles will be satisfactory. When up for re-examinations the employee must be examined with each pair of glasses.

Colored protective lenses for glasses or goggles must not be used by employees involved in the operation of trains, where duties require accurate interpretation of color signals. If goggles are worn by employees they should have a rigid type frame and if the employee requires glasses, the goggles should be fitted with corrective lenses. Clip-on lenses over regular glasses are not permitted. Glasses or goggles worn by employees using hand tools or operating power machines etc., in shops, should be made of shatter-proof glass. Under no circumstances should colored protective lenses be used by employees where the interpretation of color signals is part of the work of the employee.

CONCLUSION

The foregoing railroad minimum visual standards and test requirements are clear and easily understood by any optometrist. The professional techniques called for to meet these requirements are examination and refractive tests made daily in all optometrists' offices and should present no difficulty. Optometrists, too, have the undergraduate professional college backgrounds of training to do this work and are licensed by every State and Canadian Province as specialists in these visual and ocular matters. Optometric offices are more than adequately equipped with examining and testing instruments to enable optometrists to properly do this railroad screening work, as well as to examine and refract the employee who needs this service. There is no reason for optometrists to feel reluctant in securing more of this type of visual work.

An optometrist interested in doing this type of railroad correction should call upon the Division Superintendent who is in charge of the line in the area in which the optometrist practices. Naturally, he should first know the name of this official and a letter of introduction from some local shipper might be helpful. Before presenting himself he should be thoroughly familiar with the required schedules and regulations outlined above and should be prepared to furnish references from his State Optometric Association or from the Academy as to his professional qualifications.

ANNOUNCEMENT

AMERICAN OPTOMETRIC FOUNDATION—BOOK OF MEMORY

The American Optometric Foundation has prepared a *Book of Memory* for the benefit of research in vision. The book will provide a way for paying lasting tribute to the memory of one who has departed.

The operation of the plan is simple. A gift is sent to the American Optometric Foundation and the name of the individual whom you wish to honor is designated. His or her name is then inscribed in the *Book of Memory*. In accordance with instructions, the American Optometric Foundation sends a folder to whomever is designated, informing them that the name of the departed is being entered in the *Book of Memory*. An acknowledgment of your gift will be made to you and the amount is a matter of confidence between you and the Foundation. This memorial gift plan provides a convenient means of expressing sympathy and gives the opportunity of showing interest in the objectives of the Foundation. The amounts so contributed will be placed in the permanent fund of the Foundation. Memorial gifts should be sent to Dr. William C. Ezell, president, American Optometric Foundation, Andrews Bldg., Spartanburg, South Carolina.

BLURRING AND ASPECTS OF COLOR DISCRIMINATION*

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The physiological optics of color vision has been subjected to rather exhaustive analysis. Although many aspects have been firmly established, others, such as the exact nature of the mechanism of color blindness remain in dispute. The concept of color itself, as indicated by MacAdam and Jones (1944), is one that involves physics, psychology, and psycho-physics. Thus, hue and saturation may be said to correspond to psycho-physical characteristics of dominant wave length and purity. Davson (1949) classifies colors as "true" colors if they are seen in diffuse daylight after which they may become "memory" colors. If the color is stripped of accessory stimuli and association, such as on viewing it through a tube, Davson denotes that color as the "plane" color.

Investigation in color vision is complicated by the combination of physiological and psychological elements. Thus, Knoll (1952) reports an individual who is color blind in his left eye whenever he thinks he is seeing monocularly with that eye but who can distinguish certain colors with that eye if he is unable to tell which eye is receiving the stimulus. Other examples of the many studies in the field of color vision include those of Brown (1950) on the effect of chromatic surrounding fields on color discrimination and Brown (1951) on the influence of luminance level on visual sensitivity to color differences.

The present study was undertaken to determine, within the limits of the test conditions, the effect of blurring upon the ability to discriminate color (and, incidentally, form) with central fixation. It is known that the visual field for colors is distinctly smaller than that for form. However, Traquair (1946) states that if the intensity of light, the saturation of the color, and the size of the object are adequate, colors may be distinguished almost at the periphery of the normal visual field.

MATERIALS AND METHODS

The subjects in the tests were junior students at the Pennsylvania

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State College of Optometry. In all, forty individuals were tested, most of them for more than one test period. The subjects were tested for amblyopia, color vision defects (using the Dvorine plates), and their basic distance correction was determined in each case.

The general procedure was to start with a distinct fog produced by plus sphere lenses over the patient's correction. The general location of the test target was repeatedly indicated to the subject. The subject was instructed to fixate the target area directly and determinations were made both binocularly and monocularly. The fog was first reduced in steps of 0.50 D. and later in steps of 0.25 D. The subject was directed to report when a color was first seen by him and to name that color although he may not have been at all sure of his decision. The subject then reported when, with the degree of fog reduced, he was sure of the color and the results were recorded to the nearest 0.25 D. For the data in Tables 1-4, the degree of fog was then further reduced until the subject definitely recognized the shape as well as the color of the test objects. In the case of myopes, final results obviously might be obtained with minus lenses.

In the experiments reported in Tables 1-4, the test objects were strips of red, green, or blue paper cut in several geometric shapes, namely, a square, circle, and triangle, of varying sizes and mounted centrally on 8x11 inch sheets of white paper. Test distances were also varied, generally being two or three meters from the subject with the targets at eye level. For the data reported in Table 1, the targets were of ordinary colored paper whereas for Tables 2, 3 and 4, the targets were made of paper composed of Heidelberg colors.* The targets were illuminated by a 100-watt bulb at a distance of 50 cm.

Exposures for each series of tests were at a specific distance with targets of one basic dimension. The targets were alternated as to color and shape and also as to the monocular or binocular condition so as to distribute any variables more evenly. A subject was generally tested for about 40 minutes with rest permitted during the test to minimize fatigue, possible after-images, etc.

For the data in Table 5, the targets were of one shape only, namely 10 mm. squares composed of Wratten filters mounted on black boxes so as to be illuminated by transmitted light from the rear of the test boxes in which the filters were mounted. The targets were kept

*In the Heidelberg colors, maximum reflectance is 42% for blue at 460-470 millimicrons, 50% for green at 530-550 millimicrons, and 76% for red at 700 millimicrons.

TABLE 1

EFFECT OF BLURRING ON DISCRIMINATION OF COLOR AND FORM

Test Distance —— two meters
Targets 10 mm.[1]
N. —— 8[2]

Target		RED First[3]	RED Definite[4] M.[6]	RED Definite[4] S.D.[7]	RED Form[5] M.	RED Form[5] S.D.	GREEN First	GREEN Definite M.	GREEN Definite S.D.	GREEN Form M.	GREEN Form S.D.	BLUE First	BLUE Definite M.	BLUE Definite S.D.	BLUE Form M.	BLUE Form S.D.
Square	O.D.	4.34	2.53	.70	1.69	.67	3.84	2.15	.38	1.37	.38	3.70	2.31	1.00	.50	.48
	O.S.	4.56	2.93	.75	1.37	.51	3.90	2.25	.46	1.34	.32	4.11	2.81	.85	1.56	.43
	O.U.	6.68	4.47	.58	2.03	.36	4.94	3.25	.44	1.87	.28	5.44	3.40	.71	2.09	.36
Circle	O.D.	4.18	2.72	.86	1.15	.27	3.40	1.97	.74	1.03	.37	4.09	2.62	1.00	1.06	.26
	O.S.	4.25	2.90	.90	1.18	.33	3.03	1.81	.63	1.12	.44	4.15	2.62	.86	1.19	.33
	O.U.	5.90	4.40	.49	1.87	.38	4.90	2.84	.47	1.65	.33	5.62	3.31	.78	1.80	.33
Triangle	O.D.	4.03	2.53	.81	1.31	.18	2.47	1.50	.46	1.14	.15	3.00	1.97	.51	1.34	.34
	O.S.	4.03	2.75	.55	1.40	.45	2.78	1.50	.25	1.03	.32	3.62	2.22	.77	1.44	.31
	O.U.	5.40	3.72	.55	2.00	.25	3.81	2.09	.32	1.59	.29	4.87	2.87	.78	2.00	.30
Summary All Targets	O.D.	4.18	2.59		1.35		3.24	1.87		1.18		3.60	2.30		1.30	
	O.S.	4.28	2.85		1.32		3.24	1.85		1.16		3.96	2.55		1.40	
	O.U.	5.99	4.20		1.97		4.55	2.73		1.70		5.31	3.19		1.96	

[1]Basic Dimension = side of square, diameter of circle, side of equilateral triangle
[2]Number of individuals tested
[3]Level of plus fog in diopters at which there was first guess for color
[4]Level of plus fog at which color discrimination was definite
[5]Level of plus fog at which form discrimination was definite
[6]Mean reading in diopters
[7]Standard Deviation

TABLE 2

EFFECT OF BLURRING ON DISCRIMINATION OF COLOR AND FORM

Test Distance —— two meters*
Targets —— 10 mm. (Heidelberg)
N —— 20

Target		RED First	RED Definite M.	RED Definite S.D.	RED Form M.	RED Form S.D.	GREEN First	GREEN Definite M.	GREEN Definite S.D.	GREEN Form M.	GREEN Form S.D.	BLUE First	BLUE Definite M.	BLUE Definite S.D.	BLUE Form M.	BLUE Form S.D.
Square	O.D.	4.31	2.51	1.17	1.33	.61	3.63	2.26	.73	1.33	.51	4.16	2.53	.80	1.52	.64
	O.S.	5.13	2.93	.69	1.60	.52	4.00	2.67	.65	1.58	.53	5.05	3.00	.74	1.71	.52
	O.U.	6.94	4.00	1.20	2.00	.65	5.88	3.95	1.13	1.83	.45	6.22	4.00	1.05	2.30	.81
Circle	O.D.	3.82	2.17	.92	1.10	.39	3.04	1.83	.86	1.02	.60	3.62	2.06	.80	1.26	.57
	O.S.	4.26	2.54	.66	1.31	.43	3.43	2.23	.62	1.21	.48	4.02	2.43	.81	1.28	.51
	O.U.	6.12	3.91	1.14	1.87	.78	5.20	3.43	1.05	1.87	.71	6.00	3.90	.78	2.09	.85
Triangle	O.D.	3.69	2.20	.94	1.24	.54	2.90	1.70	.67	1.07	.39	3.18	2.01	.77	1.23	.39
	O.S.	3.75	2.14	.71	1.27	.39	3.28	1.93	.63	1.31	.48	3.57	2.13	.70	1.45	.43
	O.U.	5.47	3.13	1.06	1.80	.47	4.67	2.88	.99	1.68	.53	5.01	3.29	.84	2.95	1.15
Summary All Targets	O.D.	3.94	2.29		1.22		3.19	1.93		1.14		3.66	2.20		1.34	
	O.S.	4.95	2.54		1.39		3.57	2.28		1.37		4.21	2.52		1.48	
	O.U.	6.18	3.68		1.56		5.25	3.42		1.79		5.74	3.73		2.45	

*See footnotes for Table 1.

TABLE 3

EFFECT OF BLURRING ON DISCRIMINATION OF COLOR AND FORM

Test Distance —— two meters*
Targets —— 5-mm. (Heidelberg)
N —— 9

TARGET		RED FIRST	RED DEFINITE FORM M.	RED DEFINITE FORM S.D.	RED FORM M.	RED FORM S.D.	GREEN FIRST	GREEN DEFINITE FORM M.	GREEN DEFINITE FORM S.D.	GREEN FORM M.	GREEN FORM S.D.	BLUE FIRST	BLUE DEFINITE FORM M.	BLUE DEFINITE FORM S.D.	BLUE FORM M.	BLUE FORM S.D.
Square	O.D.	1.69	.70	.56	.61	.57	1.72	.86	.52	.78	.40	1.91	1.00	.28	.86	.27
	O.S.	2.17	1.16	.38	.92	.28	1.44	.64	.26	.61	.31	1.97	.91	.60	.86	.40
	O.U.	3.22	1.71	.41	1.39	.62	2.50	1.30	.24	1.22	.38	2.80	1.64	.57	1.30	.45
Circle	O.D.	1.94	.80	.43	.53	.33	1.53	.96	.45	.55	.41	1.83	.66	.33	.72	.54
	O.S.	1.61	.72	.60	.50	.33	1.61	.95	.36	.72	.18	1.97	.86	.34	.77	.37
	O.U.	3.16	1.64	.34	1.14	.45	2.14	1.25	.36	.92	.57	2.77	1.47	.38	1.17	.42
Triangle	O.D.	1.69	.78	.40	.61	.52	1.39	.69	.45	.69	.45	1.55	.69	.48	.61	.45
	O.S.	1.75	.58	.44	.58	.36	1.41	.69	.24	.75	.27	1.66	.61	.41	.72	.43
	O.U.	2.75	1.44	.37	1.16	.41	2.08	1.19	.40	1.14	.52	2.36	1.39	.31	1.11	.50
Summary All Targets	O.D.	1.77	.76		.58		1.55	.83		.67		1.76	.78		.73	
	O.S.	1.85	.82		.67		1.49	.76		.69		1.87	.79		.78	
	O.U.	3.04	1.60		1.23		2.24	1.25		1.09		2.65	1.50		1.19	

*See footnotes for Table 1.

TABLE 4

EFFECT OF BLURRING ON DISCRIMINATION OF COLOR AND FORM

Test Distance —— three meters*
Targets —— 15-mm. (Heidelberg)
N —— 13

		RED					GREEN					BLUE				
			DEFINITE		FORM			DEFINITE		FORM			DEFINITE		FORM	
TARGET		FIRST	M.	S.D.	M.	S.D.	FIRST	M.	S.D.	M.	S.D.	FIRST	M.	S.D.	M.	S.D.
	O.D.	3.70	2.33	.65	1.38	.31	2.96	2.00	.70	1.31	.36	3.04	2.08	.63	1.36	.41
Square	O.S.	4.06	2.25	.52	1.23	.39	2.86	1.78	.41	1.19	.36	3.81	2.52	.57	1.48	.34
	O.U.	5.60	3.66	.78	1.90	.48	4.75	3.31	.76	1.66	.79	5.19	3.46	.84	2.02	.49
	O.D.	3.00	1.73	.36	1.15	.40	3.12	1.75	.63	1.17	.41	3.35	1.96	.46	1.21	.38
Circle	O.S.	3.20	2.03	.86	1.08	.36	3.02	1.65	.51	1.17	.32	3.31	2.25	.67	1.52	.56
	O.U.	4.50	2.87	.77	1.69	.55	4.54	2.85	.71	1.62	.37	4.83	3.31	.48	2.06	.69
	O.D.	2.46	1.36	.55	1.06	.51	2.25	1.44	.52	.94	.41	2.94	1.77	.56	1.44	.45
Triangle	O.S.	3.16	1.67	.55	1.11	.46	2.65	1.52	.54	1.15	.34	2.90	1.67	.37	1.36	.36
	O.U.	4.29	2.68	.82	1.77	.36	3.56	2.29	.54	1.60	.37	4.33	2.52	.63	1.94	.40
Summary All Targets	O.D.	3.05	1.80		1.20		2.78	1.73		1.14		3.11	1.94		1.34	
	O.S.	3.47	1.98		1.14		2.84	1.65		1.17		3.34	2.15		1.45	
	O.U.	4.80	3.07		1.79		4.28	2.82		1.63		4.78	3.10		2.01	

*See footnotes for Table 1.

TABLE 5

EFFECT OF BLURRING ON COLOR DISCRIMINATION

Test Distance —— three meters
Targets —— 10-mm square Wratten filters
N —— 28[1]

	RED DEFINITE[3]			GREEN DEFINITE			BLUE DEFINITE		
	FIRST[2]	M.[4]	S.D.[5]	FIRST	M.	S.D.	FIRST	M.	S.D.
O.D.	11.29	10.12	2.62	9.27	7.00	2.45	7.61	5.28	2.42
O.S.	12.46	11.38	2.35	8.97	7.00	2.28	9.23	6.46	2.70
O.U.	14.16	12.95	2.63	12.02	9.23	3.04	11.61	8.66	4.00

[1]Number of tests made on nine subjects
[2]Level of plus fog in diopters at which there was a first guess as to color
[3]Level of plus fog at which color discrimination was definite
[4]Mean reading in diopters
[5]Standard Deviation

at eye level with the 15-watt light source 20 cm. from the filter and below the target so that the light source itself was not viewed directly. In these tests red filter #25, blue #47, and green #58 were used together with neutral density filters applied to the red and green to help to equalize luminosity. Care was taken to make the boxes light-tight to eliminate distracting blurs of white light. Although the experiments were also performed monocularly and binocularly in this series, findings were taken only as to the first guess as to color and then definite recognition. Data on form discrimination were not obtained. Otherwise, the test procedure was the same as for Tables 1-4.

RESULTS

It is evident that the results must be evaluated on a qualified basis. The nature of the tests is subjective. In addition, there is an element of guessing, although precautions against this included the use of targets of colors other than those listed so that the element of chance was perhaps one in four or five. Recognition of one color at a higher level of fog than another may well be a response to luminosity rather than to hue. There is the factor of chromatic aberration. Finally, we are dealing with recognition at minimal levels and all results are accordingly qualified.

Table 1

The experiments in this series were made using ordinary colored paper test targets with a basic dimension of ten millimeters at a distance of two meters from the plane of the cornea. The square target had a 10 mm. side, the circle a 10 mm. diameter, and the triangle, which was equilateral, a 10 mm. side. Obviously, the square had the greatest area and the triangle the least. Considering the nature of the tests, it was considered that a distance of two meters or more would virtually preclude accommodation as a factor, although the accommodative level was not determined. The table presents data for eight individuals.

Results are tabulated in this and succeeding tables by arithmetic means and standard deviations. Standard deviations were not calculated for the first guess as to color since these findings were very gross and subject to considerable variation. In some of the series, the standard deviations indicate considerable variation about the mean, but, considering the subjective nature of the tests and the 0.25 D. basic unit of measurement, these variations are perhaps not too great.

The red targets were recognized at the highest level of fog and the green at the lowest. This holds true regardless of the target shape. It may be noted that a first approximation of color recognition comes

about 1.50 D. sooner than does definite discrimination. However, in some instances such first discriminations of color were erroneous—e.g., red being called yellow and green being called blue, etc. Results for the left eye and right eye are relatively the same but there is a marked evidence of increased ability to discriminate color on a binocular basis, colors being discriminated at a consistently higher level of fog of about one diopter. The color of the squares was recognized at a slightly higher level of fog than the circles and the latter in turn at a higher level than the triangles. This may well be due to the relative differences in area.

As may be expected, the form of the targets was discriminated at a distinctly lower level of fog than the color, averaging about one diopter less. Considering all the targets together, form discrimination was made at about the same level of fog with red and blue targets, with green, slightly lower. Form discrimination with respect to target shape for objects of the same color was not too variable. It might be expected that the triangles with the smallest area would be the most difficult to discriminate but choices between squares and circles required greater discrimination, thus tending to equalize differences. In the discrimination of form there was again a higher level of fog at which the targets could be discriminated for the binocular findings as compared with the monocular.

It should be noted that the above series is a relatively small one. Slight differences between means probably would not be statistically significant.

Table 2

This series is based on a considerably higher number of test subjects, namely twenty. Test targets were of the same size as for Table 1 and also were placed at two meters. The colors were, however, of the Heidelberg series.

A comparison of results with Table 1 with respect to the summary of all targets being grouped together (at the bottom of each table) shows relative consistency, both with respect to the actual dioptral levels for each condition and the generalizations to be drawn. Red targets were again, with one exception, discriminated at the highest levels of fog, and green at the lowest. However, the differences were not great and undoubtedly not statistically significant. (We are again disregarding the tabulation for first guess as to color.) Binocular findings, however, are again consistently higher than the monocular results. In general, under the conditions of this series, a monocular fog of about 2.25 D. or more, eliminated definite color recognition whereas binocularly it required about 3.50 D.

The summary for form discrimination indicates no statistically significant difference with respect to the various colors but again, binocularly, there is a greater tolerance of fog.

As in Table 1, regardless of color, the square targets received color recognition at the highest level and the triangles at the lowest level of fog. Differences among targets for form discrimination were variable.

Tables 1 and 2 indicate color discrimination at about 1.00 or 1.25 D. higher level of fog than for discrimination of form.

Table 3

The data in this series differ from those in Table 2 in that the test targets had a five mm. basic dimension rather than 10, but they were also at a two-meter distance from the subject. Thus, there is afforded a comparison for color discrimination on the basis of size of target. The number of individuals tested was nine.

If the summary sections of Tables 2 and 3 are compared, we find that, with respect to form discrimination, the reduction of the size of the targets from 10 mm. to five mm. results in a generally similar reduction by about one-half in the level of fog necessary to eliminate form recognition. The same holds true for color discrimination, but not as consistently since the plus fog level in Table 3 is somewhat less than half of what it is in Table 2. Perhaps a greater number of experiments in this series would make for more consistent results in this respect.

Statistically, the results in Table 3 are somewhat harder to analyze since we are dealing with low dioptral levels and dioptral changes were made in units of 0.25 D. Admitting this factor, the results can nevertheless be reviewed. The summary of results at the bottom of the table show no particular difference between red, green, and blue with respect to color discrimination although the binocular advantage is again readily apparent. The same holds true for the summary of form discrimination. We may note that with these small targets, color was discriminated earlier than form, but the spread was less than heretofore and in some instances there was virtually no differences. Comparisons between form and color for each of the various-shaped targets reveal little difference, again reflecting in some measure, the statistical variables and the number of tests made. Although additional experiments may increase the spread between color and form discrimination, it may well be, at least under the conditions of the test, that color and form discrimination approach each other at these levels.

Table 4

In this series, performed on thirteen individuals, the test distance

was increased to three meters and the size of the targets to 15 mm. as the basic dimension. Relatively, therefore, on the basis of the visual angle, the results should be comparable with those in Table 2 performed at two meters with 10 mm. targets. By comparing the summary sections of both tables, this is seen to hold true evidently for form but color was discriminated at a slightly higher level of fog at the two-meter distance than at the three.

The data in Table 4 again give evidence of higher tolerance of fog binocularly than monocularly for both color and form. As in previous tables, the summary section reveals relatively similar results for each of the three colors with respect to color and form discrimination.

The data indicate that squares of each color were more easily discriminated as to color than circles, with the triangles last, but form discrimination remained relatively the same regardless of shape. Again, the slightly greater area of the squares, as compared with the triangles may account for the higher level of fog tolerated whereas discriminating between squares and circles was more difficult than discriminating triangles, thereby tending to equalize difference in area.

Table 5

The data in this series are based on a distinctly different set-up than in the previous tables. Discrimination was made only as to color, not form. Repeated tests were made on nine individuals for a total of twenty-eight findings at a distance of three meters. The targets were 10 mm. square sections of Wratten filters illuminated by transmitted light.

The data indicate very much higher levels of fog necessary to eliminate color discrimination than in previous tests. Obviously the results listed are only indicative of the circumstances in this experiment since, with different conditions of luminosity, findings would have been radically altered. We may note that the findings were definitely more variable than in previous series. The standard deviations are relatively high and findings for a number of individuals are inconsistent. For example, left and right eye discrepancies are higher than should be expected. Accordingly, the data are offered on a qualified basis since another more complete series is contemplated. From the data available, red was definitely more readily differentiated than the green or blue, which had relatively similar findings. Monocular findings were distinctly lower than binocular, following the general pattern of previous experiments.

DISCUSSION

The data listed above have indicated that, under the separate conditions of each test, the ability to recognize color when targets are

centrally fixated may be eliminated by a fog of plus sphere. Where differences exist, the data show that red discrimination is greatest. We have indicated the numerous variables of luminosity, chromatic aberration, etc., in addition to the subjective nature of the tests. All things considered, the data for Tables 1-4 are relatively consistent. An increase in the visual angle is accompanied by appropriately higher findings of fog tolerated for form and color discrimination. As may be expected, color recognition is reached before the discrimination of form.

Hartridge, as reported by Davson (1949), has demonstrated that the size of an object may be important in the subjective estimation of color. Thus, reducing the size of an object changes the color response so that yellow may change to white or gray. With extreme reduction in the size of the test object, Hartridge found that vision became colorless. In our findings, on numerous occasions, before color discrimination was definite it did go through a variety of subjective impressions so that red was called yellow, green was called blue, etc.

Running consistently through the data is the evidence for binocular reinforcement with color discrimination being attained at a distinctly higher level when the two eyes are used than when each eye is tested separately. We know that, in general, visual acuity is better binocularly. The threshold of light stimulation is lower in binocular vision but, as indicated by Davson (1949), this does not mean a summation between the two eyes. The use of the two eyes increases the chance of one receiving the necessary number of quanta from a flash of light to stimulate vision. As reported by Davson (1949), Lythgoe has given evidence that the foveal threshold is lowered in binocular vision as compared with monocular vision.

We may note that the perception of color in our tests was not attained at a clear-cut level for any series. First estimates of color run, in many cases, a diopter or more higher than when the subject felt reasonably sure of his judgment. Results at this level were quite variable, as has been stated, and standard deviations have been omitted from the tables although arithmetic means have been listed. Perhaps in one case, in Table 5, there is a variation in that the red filter was generally identified definitely as to color with only slightly less fog than for the first approximation of color.

As may be expected, the data for individuals are variable. Whether extreme differences in ability to differentiate color under a plus fog are real or reflect subjective variations in making decisions would require further investigation. In a number of instances, a subject was found to recognize color more readily under a plus fog with one eye than

with the other. Again, the data are not complete enough to warrant any conclusion in this respect.

Utilizing the above methods, further analysis is contemplated on the effect of blurring on color discrimination at extra-macular points of varying degrees.

SUMMARY

Data are presented to indicate the effect of blurring with plus lenses on the ability to differentiate color and form under certain qualified test conditions. Depending on the size of the target and its distance from the subject, color recognition can be eliminated with an appropriate fog. In one series, the data indicate that the ability to differentiate red is retained at a higher level of blur than green or blue but the results are variable in the other experiments. In general, and as may be expected, color was differentiated at a higher level of fog than form. Binocular reinforcement is evident in all tests since it required distinctly higher amounts of plus fog to eliminate color discrimination binocularly than it did monocularly.

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ANNOUNCEMENT

ACADEMY LUNCHEON AT A.O.A. CONGRESS MEETING

Dr. John D. Perry, president of the American Academy of Optometry, has announced an Academy luncheon during the annual Congress of the American Optometric Association. This luncheon will be Friday, June 15, 1956, at the Seville Hotel, Miami Beach, Florida. The Florida Chapter, American Academy of Optometry, will be in charge of the event and as usual at these luncheons there will be no speaker. President Perry will preside and all members and their guests are urged to be present. Progress reports will be presented on the planning and arrangements for the 1956 annual meeting of the Academy in Houston, Texas, in December.

PSYCHOLOGICAL PROBLEMS INVOLVED IN THE PRESCRIBING OF EYEWEAR FOR CHILDREN*

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The introduction of any artificial aid the wearing of which is obviously an admission of a physical handicap presents the psychological problem of adjustment. This is especially true when it applies to children. In the field of optometry the artificial aid most frequently prescribed is a pair of spectacles. The present paper is a consideration of the psychological problems where children are concerned and their possible solutions.

To understand the problems which may arise there must be an understanding of the psychological makeup of a child. There are basic fears which the optometrist must recognize and with which he must cope. Feelings of inadequacy and inferiority may arise when the child believes that his body is inferior to that of others. This must be recognized, for glasses tell the world that the wearer is visually handicapped and therefore physically inferior to others who do not have to rely on a prosthesis to perform adequately.

Often the problem does not present itself until the child is of school age. Gesell and Ilg[1] state that one of the greatest fears of the seven year old is that of rejection by his parents, teachers, or playmates. At this age he is vitally conscious of the attitudes of the children in his own age group. "I don't want the kids to make fun of me," is not an uncommon remark. He is beginning to be very much aware of what others might think of him. When he starts worrying about the effect the glasses are going to have on the attitudes of others toward him, the problem must be faced realistically.

Too often the child who learns that he must wear glasses is already conditioned negatively against them through the media of his social contacts. All too often motion pictures, television, fiction stories and even comic books have portrayed the spectacle wearer as a social outcast, one to be ridiculed. For example, there is the child who is portrayed wistfully watching social activities but denied the right to join in because he is "four-eyes," or the girl who is a wallflower at a dance pictured wearing a pair of spectacles. Conditioned in this way against

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glasses, is it any wonder that children often react violently against them?

At the age when acceptance by parents is a must for the mental health of the child, he may feel rejected because mother is very unhappy that he is wearing glasses. Her contemptuous attitude may tend to make him feel inadequate and unloved.

The self-preservation tendency is considered by Freud[2] to be one of the main elements in human motivation. This includes among other things the protection of all of one's moral and social standards. With this in mind, we can understand how the relationship between child and parent, child and teacher, child and playmates affects the total personality. To make social acceptance of the child as easy as possible is the responsibility of every professional person who may affect or change the pattern of a child's life. This is true when the optometrist places a pair of glasses on a child's face.

We in the field of vision expect to help the child to see better and to feel more comfortable when performing his visual tasks and as a natural consequence, to improve in his school work. But improvement of a child's performance in school is also contingent upon specific experiences in his relationship with his teacher and his classmates. Fear of ridicule or of being teased because he is wearing glasses may prevent a child from learning and may make him an introvert who avoids other children.

How can we prevent this problem or, if it exists, reduce it?

Education of both the child and the parents to accept the glasses for the important task they are to perform is the responsibility of the optometrist. If the parents are prejudiced against glasses for children, teaching them that the benefits far outweigh the one disadvantage of wearing glasses is of utmost importance since the child is influenced to a considerable degree by their attitude. Many times parents set the pattern for acceptance by the child of something new or different. Imitation of the behavior of an adult in whom the child has confidence is not uncommon and if the parents accept their own glasses or the eyewear of others with the proper mental attitude the tendency will be for the child to do the same thing.

The next consideration is the selection of a frame that is properly styled and cosmetically correct for the patient. This, as much as any other factor, will probably make the psychological adaptation take place as quickly as possible. In many cases, the aesthetic contribution of a prosthetic appliance can enhance its value to the wearer and this is especially true in the case of eyewear. So many smartly styled frames are available for children that the wearing of glasses can many times

actually be enjoyable if the selection of the eyewear is handled properly. If the glasses are attractive enough to draw compliments instead of jeers or pity, an invaluable service has been performed for that child.

Within the past few years, the styling of eyewear for children has undergone a drastic change for the better. Previous to this time, the stress was strictly on functional eyewear. Now function has been combined with attractiveness to help make the wearing of glasses as easy on the ego as possible.

Perhaps the greatest contributing factor to the attractiveness of eyewear for a little girl is color. Manufacturers are making frames available in a wide range of hues for the younger female patient.

Color selection is influenced primarily by the patient's own general coloring. Although most little girls look smart in the pastel and bright hues, there are usually a few colors that are best for a specific individual. A blonde girl, for example, generally is most attractive in a blue or pink frame. The redheaded child wears green and blue best, while the little brunette is most striking in a bright color such as red. The little brownette is the most fortunate because she wears all colors well. Usually to be avoided are the dark colors that tend to make a child look pale or drab.

Interesting details are often added to enhance the appearance of a little girl's frame. For example, trims shaped like pink roses add to the loveliness of a pink plastic frame. Miniature gold and silver trims brightened by a single rhinestone add a special touch of youthful glamour. Appliques shaped like little dolls are enjoyed by the younger child.

There is little choice in color when selecting eyewear for a little boy. Frames are manufactured mostly in shades of brown. The light browns usually look best on the blonde or light brown haired patient, while the darker shades are more becoming to the brunette. One of the frame manufacturers will make available shortly a charcoal and crystal frame that is especially attractive on a dark-haired child. At the same time a slate blue and crystal frame that is becoming to the blonde or blue-eyed child will be released.

For a little boy, following through with a popular theme will often make the wearing of glasses a pleasure. Younger children who enjoy cowboy games, movies, etc., will often enjoy wearing cowboy glasses which have appliques in the form of guns, cowboy hats or horses attached to the endpieces. An added attraction is a cowboy case that slips on the child's belt.

Frames are also available with trims in the form of space ships or rockets. Coupled with a space patrol case, the little boy planning his

trip to the moon is not too likely to form a resentment against wearing glasses.

Children often derive more enjoyment from the things they have had the chance to select. For this reason the child should be allowed to make his own final selection from several frames that are in good taste and cosmetically correct for him.

The child's adjustment to his environment is influenced by so many complex factors that no one specific point can be brought out as being the most important one. This paper is not intended to give the impression that the influence of eyewear alone can be the determining factor in this complex scheme of development, but if it gives the optometrist insight into the problem its purpose has been accomplished.

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CORRESPONDENCE

MICROSCOPIC AND TELESCOPIC SPECTACLES

To the Editor:

I appreciate the opportunity of calling to your attention an article in the March issue of BETTER HOMES AND GARDENS entitled *"Escape from Blindness."* This article calls to the attention of the general public the advantage of microscopic and telescopic visual aids. The public service of this type of story is very great as we frequently find new people coming forth who are materially benefited by the new technical advancements.

I think Dr. William Feinbloom is to be complimented for his work, and the editor of BETTER HOMES AND GARDENS certainly deserves commendation for his interest in the visually handicapped person.

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THE DISCREPANCY BETWEEN PHYSICAL AND PERCEIVED CURVATURE*

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INTRODUCTION

This paper presents an explanation of the discrepancy between the physical and perceived curvature of a surface which is normal to the median line when the eyes are converging symmetrically. Consideration will be limited to the case in which the observer is free from aniseikonia so that the trace of the horopter in the plane of regard is symmetrical with respect to the median line.

COORDINATES OF PHYSICAL SPACE

Rectangular coordinates will be used to designate the position of a point in the plane of regard in physical space (Figure 1A). The

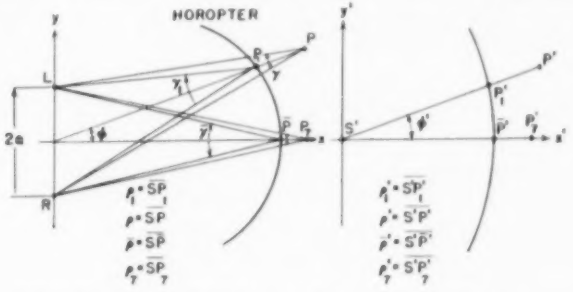

Fig. 1. Relationship between various points in physical space and their counterparts in visual space.

x-axis passes through the point of fixation $\overline{P}$ and the midpoint S of the interpupillary line connecting the centers of the entrance pupils R and L of the right and left eyes. The y-axis lies perpendicular to the x-axis at S and in the case of symmetrical convergence coincides with the interpupillary line.

The point P represents any point in the plane of regard which lies on the radial vector SP at an angle ϕ from the x-axis, and at a distance ρ from S. γ represents the binocular parallax of the point P.

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As long as P is reasonably remote from S, it is satisfactory to assume that

$$\gamma = \frac{2a \cos \phi}{\rho} \quad (1)$$

where γ is expressed in radians and 2a is the interpupillary distance. For small values of ϕ,

$$\gamma = \frac{2a}{\rho}. \quad (2)$$

COORDINATES OF VISUAL SPACE

Rectangular coordinates x′, y′ will be used to designate the position of the point P′ in visual space (Figure 1B), which corresponds to P in physical space. The x′ and y′ axes of visual space coincide with the x and y axes of physical space. As shown in Figure 1B polar coordinates ϕ' and ρ' can also be used to designate the position of P′.

THE RELATIONSHIP BETWEEN ϕ' AND ϕ.

For the present purpose it is satisfactory to assume that

$$\phi' = \phi. \quad (3)$$

THE HOROPTER

The horopter is the locus of points in physical space which form images on corresponding parts of two retinas. The dextrocular and sinistrocular images of such points are seen in the same direction.

In Figure 1A the trace of the horopter in the plane of regard is represented by a curve concave to the observer which passes through the point of convergence $\overline{P}$. P_1 represents any point on the horopter at an angular distance ϕ from $\overline{P}$. P represents any point in front of or behind the horopter which lies on the same radial vector as P_1. P_2 represents any point on the x-axis and may lie in front of or behind $\overline{P}$

THE USE OF RETINAL DISPARITY IN EVALUATING RELATIVE DISTANCES

An observer can make use of the relative retinal disparities of the two points P and P_2 to evaluate their relative distances. Since $\overline{P}$ lies on the horopter the images formed by the left and right eyes fall on corresponding points and the retinal disparity is zero. P_2 which lies off the horopter, produces images which fall on non-corresponding points and the amount of disparity is directly proportional to $(\overline{\gamma} - \gamma_2)$.

In accordance with equation (2)

$$\overline{\gamma} - \gamma_2 = \frac{2a}{\rho} - \frac{2a}{\rho_2}. \quad (4)$$

Let us suppose in the case of small values of ϕ that a person learns to

perceive differences in distance by using his hands to hold one object at the point of fixation $\bar{P}$ and a second object at P_2 and by noting the relation between the disparity of the retinal images of P_2 perceived through the eyes and the displacement of P_2 in front of $\bar{P}$ perceived through the hands. In this case the perceived distances are actually equal to the physical distances and hence

$$\frac{1}{\bar{\rho}'} - \frac{1}{\rho'_2} = \frac{\bar{\gamma} - \gamma_2}{2a}. \tag{5}$$

After a person has used his hands to learn the relation between retinal disparity and displacement of P_2 in front of or behind the horopter, let us inquire what use he can make of this skill when he stops using his hands.

It may be supposed that he can use this learned relation to evaluate the relative distances of $\bar{P}$ and P_2: that is to say, if he can evaluate $\bar{\rho}$ on any basis whatever he can use his information about the disparity of the retinal images of P_2 to evaluate the relative displacement of P_2 in front of or behind $\bar{P}$.

It may also be supposed that he can use this learned relationship to evaluate the displacement of P in front of or behind P_1 on the basis of the disparity of the retinal images of P. In other words,

$$\frac{1}{\rho'_1} - \frac{1}{\rho'} = \frac{\gamma_1 - \gamma}{2a} = \frac{\cos\phi}{\rho'_1} - \frac{\cos\phi}{\rho}. \tag{6}$$

THE USE OF SIZE CONSTANCY IN EVALUATING DISTANCES

The next problem is that of learning to evaluate the relative distances of ρ and ρ_1. It is proposed that this occurs in an environment of moving objects, and that in such an environment, the brain arrives at its evaluation of ρ'_1 for each of the various radial vectors by re-assessing ρ'_1 until objects moving in a fore and aft direction along each radial vector appear to maintain a constant size in the fore and aft direction. In order for this to happen $d\rho'/d\rho$ must be equal to a constant, and in order for this condition to be filled it is necessary that

$$\frac{\rho'}{\rho} = \frac{\rho'_1}{\rho_1} = \sec\phi. \tag{7}$$

This means that along every given radial vector, ρ' is proportional to ρ.

In the case of $\bar{P}$ the value of ϕ is zero and ρ' is actually equal to ρ. However, in the case of a point on the horopter P_1 which lies off the x-axis, the distance is overestimated by a factor equal to sec ϕ. The

net result is that the counterpart of the horopter in visual space is tangent to the horopter in physical space at the point of fixation $\bar{P}$ but is less curved.

AN EQUATION FOR THE COUNTERPART OF THE HOROPTER IN VISUAL SPACE

The horopter in physical space can be represented by the equation

$$\bar{\gamma} - \gamma_1 = H_1 \phi^2 \tag{8}$$

when the subject is free from aniseikonia. In this equation H_1 is some function of ρ.

Since from Equations (1), (2) and (7)

$$\bar{\gamma} = \frac{2a}{\bar{\rho}} = \frac{2a}{\bar{\rho}'} \tag{9}$$

and

$$\gamma_1 = \frac{2a \cos \phi}{\rho_1} = \frac{2a}{\rho'_1}, \tag{10}$$

Equation (8) becomes

$$\frac{1}{\rho'_1} - \frac{1}{\bar{\rho}'} = - \frac{H_1 \phi^2}{2a} \tag{11}$$

which is an equation for the counterpart of the horopter in visual space.

Essentially the job which the brain must perform is to associate with each value of $\bar{\rho}'$ a surface of a certain curvature as representing the counterpart of the horopter in visual space and then objects in front of or behind the horopter are perceived in relation to the counterpart of the horopter in visual space.

As pointed out above $\bar{\rho}'$ can be expected to be epual to $\bar{\rho}$ in an environment of moving objects. But in an environment of fixed objects this is apt not to be the case, but it may be assumed that Equation 11 still holds, except that it is necessary to substitute H'_1 for H_1 where H'_1 represents the same function of ρ' as H_1 is of ρ, so that

$$\frac{1}{\rho'_1} - \frac{1}{\bar{\rho}'} = - \frac{H'_1 \phi^2}{2a}. \tag{12}$$

GENERAL EQUATION RELATING ρ' TO ρ

Since Equation (12) holds even in a fixed environment where ρ' is not equal to $\bar{\rho}$, it follows from Equations (12) and (8) that

$$\frac{1}{\rho'_1} - \frac{1}{\bar{\rho}'} = \frac{\gamma_1 - \bar{\gamma}}{2a}. \quad (13)$$

If in this case

$$\frac{1}{\bar{\rho}'} = \frac{\bar{\gamma}}{2a} + k . \quad (14)$$

It follows from (13) that

$$\frac{1}{\rho'_1} = \frac{\gamma_1}{2a} + k \quad (15)$$

and from (6) that

$$\frac{1}{\rho'} = \frac{\gamma}{2a} + k = \frac{\cos \phi}{\rho} + k . \quad (16)$$

Equation (16) represents a general equation relating ρ' to ρ which is applicable to any point P.

By means of this equation one can predict the configuration of the counterpart of a V-M circle in visual space and also the configuration of the trace of the apparent frontoparallel plane in the plane of regard. The agreement between the predicted configurations and those found by experiment provides a test of the validity of the equation.

THE VISUAL COUNTERPART OF THE V-M CIRCLE

The Vieth-Muller circle in physical space passes through the point of fixation and the centers of the two entrance pupils. See Fig. 2. The value of γ_2 is constant for all values of ϕ, i.e.,

$$\gamma_2 = \bar{\gamma} . \quad (17)$$

If we apply Equation (16) to a point on the V-M circle, the equation reduces to

$$\rho' = \bar{\rho}' . \quad (18)$$

Hence the visual counterpart of the V-M circle is a circle in visual space concentric with S'.

Luneburg[1] has observed points arranged to conform to a V-M circle and has reported that these points appear to be on a circle concentric to the observer.

THE APPARENT FRONTO-PARALLEL PLANE (AFPP)

The AFPP is a surface in physical space which is perceived as a frontoparallel plane in visual space, i. e., one which is perpendicular to

*In deriving this equation it is necessary to assume that the difference between H_1 and H'_1 is negligible.

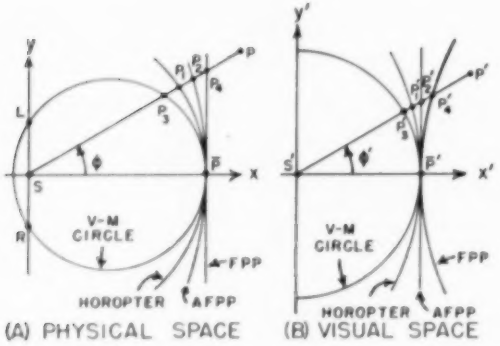

Fig. 2. The relation between various curves in the x, y plane of physical space and their counterparts in visual space.

the median line. Let us consider the AFPP which intersects the median line at $\bar{P}$. Its counterpart in visual space is given by the following equation:

$$\rho'_2 = \frac{\bar{\rho}'}{\cos \phi'} \tag{19}$$

where ρ'_2 is the perceived distance of a point P_2 on the AFPP through $\bar{P}$ at a distance ϕ from the x axis.

If we apply Equation (16) to a point on the apparent fronto-parallel plane

$$\bar{\gamma} - \gamma_2 = \frac{2a}{\bar{\rho}'} - \frac{2a}{\rho'_2} . \tag{20}$$

Substituting $\frac{\bar{\rho}'}{\cos \phi'}$ for ρ'_2 we obtain

$$\bar{\gamma} - \gamma_2 = \frac{2a}{\bar{\rho}'} (1 - \cos \phi') \tag{21}$$

For small values of ϕ'

$$(1 - \cos \phi') = \frac{\phi^2}{2} \tag{22}$$

and hence

$$\bar{\gamma} - \gamma_2 = \frac{a}{\bar{\rho}'} \phi^2 . \tag{23}$$

The term $\frac{a}{\rho'}$ is a constant for each AFPP and may be designated H_2 and called the Hering Hillebrand deviation coefficient.

In order for the hypothesis proposed above to be correct, the experimentally determined AFPP must conform to Equation (23), and it may be noted that the Equation for the AFPP found experimentally does conform to Equation (23), provided

$$H_2 = \frac{a}{\rho'} = a \left(\frac{1}{\rho} + k \right) . \qquad (24)$$

The data relating H_2 to ρ have been summarized by Ogle[2], but no attention has been paid to the variation of k with ρ and until information on this point is available, it will not be possible to determine to what extent Equation (23) agrees with experimental data. The indications are that the agreement may be reasonably good.

VISUAL COUNTERPART OF THE FRONTOPARALLEL PLANE (FPP) IN PHYSICAL SPACE

The frontoparallel plane in physical space conforms to the equation

$$\rho_4 = \frac{\rho}{\cos \phi} . \qquad (25)$$

If Equation (16) is applied to a point P_4 on the FPP, we obtain an equation for the counterpart of the FPP in visual space, namely

$$\frac{1}{\rho'_4} = \frac{1}{\rho'} + \frac{(\gamma_4 - \bar{\gamma})}{2a} \qquad (26)$$

$$\text{since } \bar{\gamma} - \gamma_4 = \frac{2a}{\rho} - \frac{2a \cos \phi}{\rho_4} = \frac{2a}{\rho} \sin^2 \phi . \qquad (27)$$

Equation (26) reduces to

$$\frac{1}{\rho'_4} = \frac{1}{\rho'} - \frac{\sin^2 \phi}{\rho} . \qquad (28)$$

THE RELATION BETWEEN PERCEIVED DISTANCE AND THE PERCEIVED CURVATURE OF A PLANE SURFACE NORMAL TO THE X-AXIS

The counterpart in visual space is convex to the observer. The amount of convexity will depend upon its perceived distance (i. e., upon the value of k), and since the eyes must learn to associate certain cur-

vatures with certain distances, perceived curvature and perceived distance become interchangeable quantities. This makes it possible to explain how an illusion of distance can be created with a pair of asymmetrical magnifiers.[3]

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2. K. N. Ogle. Binocular Vision. Philadelphia. pp. 32-35 (1950).
3. A. Ames, Jr., Binocular vision as affected by relations between binocular stimulus patterns in commonplace environments. Amer. J. Psych., 59, 333-357 (1946).

AMERICAN ACADEMY OF OPTOMETRY

IN MEMORIAM

Anno Domini

1955

The Rt. Hon. Lord Charnwood, London, England.
Dr. Clyde J. Hathaway, Pontiac, Michigan.
Dr. Joseph I. Pascal, New York, New York.
Dr. D. H. Pratt, New York, New York.
Dr. Seymour L. Shaw, Wheeling, West Virginia.
Dr. Frederick A. Woll, New York, New York.

Since our last annual meeting the Academy has lost six of its members through death. Each of these men played a significant part in the development of the profession and each by his splendid work has left his important mark on the present and future of optometry. All have been active in the Academy. We miss these important leaders and the membership of the Academy at this time pays tribute to their memory.

(From the minutes of the Chicago, Illinois, meeting of the Academy.)

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SCOPE OF EDUCATION AT ANNUAL ACADEMY MEETING

The December meeting of the American Academy of Optometry has long been the outstanding annual educational event in the optometric profession. With the added three day postgraduate course preceding the regular meeting, the seven-day session in Chicago was probably the most ambitious optometric postgraduate education program in history.

So successful was the Chicago meeting, that the postgraduate courses will be a regular annual event. It is well, therefore, to present to the profession the underlying philosophy in the three different types of educational endeavor which are now a regular part of the Academy's annual meeting.

(A) *General Papers Sessions.* These sessions are held from 11:00 A.M. until 9:00 P.M. on the last four days of the meetings and

are similar to those of many other scientific bodies. It is here that new material of theoretical and clinical nature is presented to all Fellows. In true scientific spirit, the discussion after each paper serves to clarify points and to further question the author on technique or theory. The papers at these sessions are "new" in the sense that they have not formerly appeared in print. Each paper, after it has been presented, is published in this JOURNAL during the ensuing year. The papers represent research, usually of the previous year. The emphasis, however, is not solely on theoretical research, but also on bibliographic studies and clinical research.

(B) *Section Meetings.* The section meetings are held from 9:00 A.M. to 11:00 A.M. on each of the last three days of the meeting. Here the emphasis is distinctly clinical, and it is the purpose of the section meetings to enable optometrists with similar specialized interests to get together and discuss their experiences. Papers presented at the section meetings, for the most part, are of a specialized nature and pertain more to different aspects of technique than to broader principles. At present, there are five Sections of the Academy, namely: Aniseikonia, Contact Lens and Subnormal Vision, Pathology, Occupational Optometry, and Orthoptics. Since these five section meetings run concurrently, the Fellow is often forced to decide between two or more meetings of almost equal interest to him. However, all papers of a general nature given at section meetings are published in this JOURNAL. That these sections meet concurrently and that difficult choices must be made is evidence of the broad scope of optometry and the immense strides in clinical applications made each year. In general, the Section meetings are less formal than the general sessions and there is more opportunity for clinical demonstration, discussion, and presentation of special problems by the audience as well as the speaker.

(C) *Postgraduate Courses.* These courses (thirty-eight of them at the last meeting) are offered during the three days before the general meeting. Classes begin at 8:00 A.M. and continue until 9:30 P.M. During this period, at least two courses are offered concurrently. Here again the optometrist must make a decision as to which of two or more subjects is of greater interest to him. In these courses, the emphasis is not so much upon new research as upon a comprehensive presentation of certain phases of optometry to keep the optometrist abreast of the times. Those presenting the courses teach, rather than present material, as in the general sessions. Many of the specialized aspects, such as contact lenses and subnormal vision aids, are presented at the courses. The courses vary in length from one to eight hours, and where technique

is taught, the enrollment is limited to allow the instructor to do the best possible teaching.

Perhaps the best explanation of the function served by each of the three types of meeting would be one which considered the relationship between listener and speaker. At the general sessions, the relationship is that of one scientist to another, or of a scientist to a clinician. The material which represents original and recent research is presented, and the listener is expected to make what he will of it. At the section meetings the relationship is that of one clinician to another with the scope of the discussion limited to one small aspect of the general optometric field. At the postgraduate courses, the relationship is that of teacher and student. Material which has changed in recent years is presented in a classroom atmosphere. Basic optometric courses are reviewed and taught.

From the above discussion, it will be readily apparent that the scope of the annual Academy meeting is now greater than anything in optometry's past. This is in keeping with the vigorous growth of the profession, the rapid pace of research, and the avid desire of optometrists to learn. Some optometrists benefit most by one type of program, others by another, and most, by all three. One thing, however, is certain, and that is that no optometrist can fail to get some information from some part of the meeting. The mere scope of the program is in itself inspirational. Optometrists would do well to begin planning now to attend the next annual meeting in Houston, Texas, in December.

MONROE J. HIRSCH

DATES ANNOUNCED FOR ACADEMY POST-GRADUATE COURSES

December 5, 6 and 7, are the dates and the Shamrock Hotel, Houston, Texas, is the place for the 1956 Post-graduate Courses conducted by the American Academy of Optometry's Committee on Instruction. Many of optometry's leading educators and clinicians have already consented to give courses in their areas of special knowledge.

About 40 courses will be given, varying in length from one to twelve hours.

The first Post-graduate Courses given by the American Academy of Optometry were held in Chicago last December and were an outstanding success.

V. J. ELLERBROCK

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

WORK SPEEDED ON ILLINOIS COLLEGE OF OPTOMETRY CLINIC

Work on the new clinic of Illinois College of Optometry, Chicago, started two months ago has been stepped up in order to meet the deadline for completion of early summer, according to a statement made by Dr. Eugene W. Strawn, Freeport, president.

"The board of trustees intends to provide the most comprehensive eye clinic in the country in which to train students," he said. "This is the first major project in the proposed expansion program as announced by the board last fall."

The large building now undergoing extensive remodelling was purchased by the board shortly after the merger of the former Chicago and Northern Illinois colleges. Just south of the college, it consists of ground floor and three full stories, and was previously used for apartments. Walls are being moved or torn out, small doorways closed up and larger ones added to provide 20,000 square feet of floor space for clinical, research and laboratory uses. When completed the new clinic will represent a total investment of $200,000.00, Dr. Strawn said.

Already finished and in use is the student lounge located in the front section of the ground floor. Panelled in Phillippine mahogany, it has an asphale tile floor, indirect lighting and other touches which combine to make a large attractive room.

"In addition to renovating the interior of the building," he went on, "the lower portion of the exterior also is being changed to conform to the modern architectural design of the main college building. The upper part of the exterior will be revamped along similar lines just as soon as funds are available."

Among the outstanding features of the clinic will be 25 full sized, air conditioned refracting rooms, each to be a complete unit equipped with all available makes and kinds of ophthalmic instruments and devices. More than 3,000 square feet have been allocated for the vision training department. Dr. Leo Manas, visual training director for the college, has assisted in planning the detailed specifications.

Expert advice of other faculty members has been followed in arranging for space and in setting up other departments. A specially constructed amphitheatre will be included in the ocular pathology

section. Provision has been made for separate departments for children's vision, contact lenses, and subnormal vision aids. The perimetry and fields laboratories likewise will be enlarged, according to Dr. Strawn.

EASTERN PENNSYLVANIA CHAPTER

A meeting of the Eastern Pennsylvania Chapter, American Academy of Optometry was held in Philadelphia, February 1. The speaker was Dr. Elona Sochor, Director of the Temple University Reading Clinic. Dr. Sochor reviewed the work now being done by the clinic and her talk was followed by a lengthy question and answer period. The meeting was attended by 45 members and guests. Dr. Alvah R. Cooley, Jr., Langhorne, presided.

AN OPTICAL FAIR FOR 1957

The Optical Manufacturers Association held its annual meeting in New York City, January 19. The association voted to hold an Optical Fair in 1957 and each year thereafter. The last Optical Fair was held in Chicago in June of 1954.

At the meeting William R. Grossman, Optical Products Corporation, was named president of the association. Fred Soden, Continental Optical Company, vice president, and four members of the executive committee to serve three-year terms: R. O. Barber, Univis Lens Company; Herman Goodman, Zylite Products Company; W. J. Murray, Sr., Universal Optical Company and Eldon R. Siebl, Vision-Ease Corporation, were also elected.

The association also adopted a series of lens quality standards which had been under study for some time.

CLEVELAND FORUM ON VISUAL PROBLEMS IN SCHOOLS

More than 200 optometrists and 1,200 teachers from 17 states attended the Ninth Annual Forum on Visual Problems in Schools and the Reading Conference held in conjunction with it at the Statler Hotel, Cleveland, Ohio, February 24-26.

The theme of the meeting was the importance of interprofessional cooperation in meeting the needs of children, and 22 speakers from optometry, education, and medicine participated in the program. The sponsors were the American Optometric Association, the Northeastern Ohio Section of the American Academy of Optometry and the Ohio Unit of the newly-formed International Reading Association. The general chairman of the meeting was Dr. Lois B. Bing, Cleveland, Chairman of the AOA Committee on Visual Problems in Schools.

BAUSCH & LOMB TO OWN SOFT-LITE TRADEMARKS

Nathaniel Singer, President of Soft-Lite Bay State Optical Com-

pany, New York, announces the sale to the Bausch & Lomb Optical Company, Rochester, New York, of the world distribution rights for Soft-Lite Lenses. Soft-Lite Lens trademarks have been in use for many years in more than fifty foreign countries. The U.S.A. registration dates from 1908.

The Soft-Lite Lens Company, successor to the Optical Service Corporation, continued the introduction and sole sale of Soft-Lite Lenses in the domestic and world markets from its inception in 1929. More than twenty million pairs of Soft-Lite Lenses have been sold since 1921 when Nat Singer undertook the extension of Soft-Lite sales across the country—and then throughout the world.

His father, Morris Singer, named and introduced Soft-Lite in New York City early this century. Initially the raw glass was imported, but in 1924 Bausch & Lomb were entrusted with its manufacture from the raw glass through the finished product, in four shades, in single vision, bifocals and trifocals.

The disposal of the Westbury, Long Island, frame plant and its assets have recently been completed as well, so that the stockholders of the Soft-Lite Bay State Optical Company—now in it's final stages of liquidation—will receive a satisfactory liquidating total on payment of the final dividends by mid-1956.

Nathaniel Singer is planning to continue his work in the industry as optical consultant to firms whom he may benefit from his thirty-four years intensive experience in this field. His offices will remain in the Squibb Bldg., 745 Fifth Avenue, New York City.

VISUAL TRAINING TECHNICIANS CONFERENCE

The Optometric Extension Program held the tenth annual Visual Training Technicians Conference at the Hotel Texas, Fort Worth, February 11-12. The conference is planned to bring new orthoptic techniques to the attention of visual training assistants. Papers were presented by Dr. Jane Brent, Houston; Dr. Violet Dorris, Denton, Texas; Mrs. Marye Wicker, Clovis, New Mexico; Dr. A. M. Skeffington, St. Louis; Dr. Jean May, Dallas; Dr. Ralph Barstow, Austin; Mrs. Rosemary Harmon, Austin; Mrs. Vivian Martin, Fort Worth; Judy Garton, Roswell, New Mexico; Mrs. Louise Day, Kaufman, Texas; Jeannette Carr, Lake Charles, La.; Mrs. Ruth Reuther, Gainesville, Texas; Dr. Mary Childress, Longview, Texas; Dr. Mary Jane Skeffington, St. Louis; Mrs. Ruth Roderick, Dallas; Mrs. Gladys Downs Taylor, San Antonio; and Mary Carns, Forth Worth. A large number of orthoptists from nine southern and western States attended the meeting.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ACADEMY MONOGRAPHS

One of the popular educational services offered optometrists by the American Academy of Optometry is the publication and distribution of low cost technical monographs. These specially published reprints deal with a great variety of subjects of interest and value to optometrists.

Each monograph is authored by one or more specialists in the selected subject. Not only is this service popular because of its low cost, it is even more popular because of the authoritative positions held in optometric practice by those optometrists and educators who have written the extensive material included in this series of now available monographs. This is a continuing service and the profession already recognizes the conservatism and competence of this large body of clinical and scientific writers.

These educational monographs report studies in various fields of optometric practice. This series is unique in its contribution to the *Science of Seeing*, presenting a body of material covering many aspects of the subject. These monographs represent a type of clinical and scientific material which is indispensable to the optometrist, research worker, educator and to the student of visual problems.

The nearly 200 different titles offer a very wide selection covering most phases of optometric practice. These 6" x 9" monographs vary in size from 8 to 72 printed pages. Each reprint is bound in heavy board covers for permanence.

These monographs will be mailed, postpaid, to professionally interested persons upon receipt of order accompanied by the cost of the reprint or reprints ordered. Payment with orders is essential. Stamps or coins are acceptable on small orders. In ordering monographs selection should be made by number.

The 1956 listing of available monographs follows. This list supersedes prior published lists and only those monographs now catalogued are offered at this time. See pages 162-170.

Orders and checks should be sent to the American Academy of Optometry, 1508 Foshay Tower, Minneapolis 2, Minn.

RUDOLPH EHRENBERG

ACCOMMODATION AND CONVERGENCE — TESTS AND IMBALANCES

- ☐ Monograph No. 150. Merrill J. Allen. An Investigation of the Time Characteristics of Accommodation and Convergence of the Eyes. Historical Review. 8 p. + cover. 25c.
- ☐ Monograph No. 151. Merrill J. Allen. An Investigation of the Time Characteristics of Accommodation and Convergence of the Eyes. Subjective Determination of Accommodation and Objective Recording of Convergence. 12 p. + cover. 30c.
- ☐ Monograph No. 82. Merrill J. Allen. An Objective High Speed Photographic Technique for Simultaneously Recording Changes in Accommodation and Convergence. 12 p. + cover. 30c.
- ☐ Monograph No. 76. Mathew Alpern. Accommodation and Convergence with Contact Lenses. 12 p. + cover. 30c.
- ☐ Monograph No. 108. Mathew Alpern. The Zone of Clear Single Vision at the Upper Level of Accommodation and Convergence. 24 p. + cover. 45c.
- ☐ Monograph No. 173. Robert E. Bannon. Physiological Factors in Multifocal Corrections. 16 p. + cover. 35c.
- ☐ Monograph No. 141. Robert E. Bannon. Space Perception—Some Physiological Aspects. 16 p. + cover. 35c.
- ☐ Monograph No. 176. Merton C. Flom. Variations in Convergence and Accommodation Induced by Successive Spherical Lens Additions with Distance Fixation—An Investigation, with the Description of a Clinical Method for Testing the Validity of the Refractive Correction. 28 p. + cover. 50c.
- ☐ Monograph No. 147. Glenn A. Fry. Research in Accommodation and Convergence. 8 p. + cover. 25c.
- ☐ Monograph No. 34. Monroe J. Hirsch. The Stereoscope as a Method of Measuring Distance Discrimination. 8 p. + cover. 25c.
- ☐ Monograph No. 55. Henry W. Hofstetter. Accommodative Convergence in Identical Twins. 12 p. + cover. 30c.
- ☐ Monograph No. 128. Elwin Marg. "Flashes" of Clear Vision and Negative Accommodation with Reference to the Bates Method of Visual Training. 20 p. + cover. 40c.
- ☐ Monograph No. 102. Meredith W. Morgan, Jr. A Comparison of Clinical Methods of Measuring Accommodative Convergence. 12 p. + cover. 30c.
- ☐ Monograph No. 118. Meredith W. Morgan, Jr. Accommodation and Convergence in a Patient with Adie's Pupil. 12 p. + cover. 30c.
- ☐ Monograph No. 149. Max Schapero and Morton Levy. The Variation of Proximal Convergence with Change in Distance. 16 p. + cover. 35c.

ANISEIKONIA AND THE EIKONOMETRIC TECHNIQUES

- ☐ Monograph No. 69. Robert E. Bannon. Aniseikonia and Binocular Vision. 12 p. + cover. 30c.
- ☐ Monograph No. 1-A. Robert E. Bannon. Heterophoria and Aniseikonia. 12 p. + cover. 35c.
- ☐ Monograph No. 1-B. Robert E. Bannon. On the Technique of Measuring and Correcting Aniseikonia. 24 p. + cover. 45c.
- ☐ Monograph No. 144. Robert E. Bannon. Space Eikonometry in Aniseikonia. 16 p. + cover. 35c.
- ☐ Monograph No. 141. Robert E. Bannon. Space Perception—Some Physiological and Psychological Aspects. 16 p. + cover. 35c.
- ☐ Monograph No. 103. Robert E. Bannon, F. H. Cooley, Harold M. Fisher and R. E. Textor. The Stigmatoscopy Method of Determining the Binocular Refractive Status. 16 p. + cover. 35c.
- ☐ Monograph No. 28. Robert E. Bannon and Rudolph T. Textor. Analysis of Successful and Failure Aniseikonic Cases. A Study of the Data in 200 Cases. 16 p. + cover. 35c.
- ☐ Monograph No. 138. V. J. Ellerbrock. The Effect of Aniseikonia on the Amplitude of Vertical Divergence. 16 p. + cover. 35c.
- ☐ Monograph No. 66. Harold M. Fisher. A Modification of Space-Eikonometer Technique. 8 p. + cover. 25c.

☐ Monograph No. 172. A. Harry Malin. Testing Aniseikonia with a Simplified Space Eikonometer. 12 p. + cover. 30c.
☐ Monograph No. 72. Oscar L. McCulloch. A Report on Three Cases of Aniseikonia. 8 p. + cover. 25c.
☐ Monograph No. 187. Arene T. Wray. Clinical Report on the Correction of Aniseikonia in Cases of Low Refractive Error. 8 p. + cover. 25c.

CONTACT LENSES AND CONTACT LENS FITTING

☐ Monograph No. 76. Mathew Alpern. Accommodation and Convergence with Contact Lenses. 12 p. + cover. 30c.
☐ Monograph No. 1. Solon M. Braff. The Fitting of Contact Lenses by the Molding Technique. 24 p. + cover. 45c.
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See page 161 for complete instructions for ordering from this Catalogue of Academy monographs.

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ou have patients for us to see for r a beginning fitting or a consul- n, please contact us beforehand n appointment. For these patients ave set up a separate time. If the se will be given during the week, linic hours will be from 3:30 p.m. 00 p.m. If the course will be given Sunday, the clinic hours will be 10:30 a.m. to noon. BE SURE VRITE TO US BEFOREHAND AN APPOINTMENT FOR R PATIENT. *Also, do remember ing your patient's case history.*

SECOND PORTION SPRING SCHEDULE

STATE & CITY	DATE	TIME	TYPE COURSE	HOTEL
Kentucky:				
Louisville	Sun., April 15	1:00 p.m. to 5:00 p.m.	A & B	Henry Clay
Tennessee:				
Nashville	Sun., April 15	1:00 p.m. to 5:00 p.m.	A & B	Dinkler-Andrew Jackson
Knoxville	Mon., April 16	7:00 p.m. to 10:00 p.m.	A	Andrew Jackson Hotel
Chattanooga	Mon., April 16	7:00 p.m. to 10:00 p.m.	A	Hotel Patten
Georgia:				
Atlanta	Tue., April 17	7:00 p.m. to 10:00 p.m.	A & B	The Dinkler Plaza
North Carolina:				
Charlotte	Wed., April 18	7:00 p.m. to 10:00 p.m.	A	Hotel Charlotte
South Carolina:				
Columbia	Wed., April 18	7:00 p.m. to 10:00 p.m.	A	Hotel Columbia
Charleston	Wed., April 18	7:00 p.m. to 10:00 p.m.	A	Fort Sumter Hotel
West Virginia:				
Charleston	Fri., April 20	7:00 p.m. to 10:00 p.m.	A & B	The Daniel Boone
Ohio:				
Cincinnati	Sun., April 22	1:00 p.m. to 5:00 p.m.	A & B	Netherland Plaza
Columbus	Sun., April 22	1:00 p.m. to 5:00 p.m.	A & B	Deshler Hilton Hotel
Cleveland	Fri., April 27	7:00 p.m. to 10:00 p.m.	A & B	Hotel Statler
Akron	Fri., April 27	7:00 p.m. to 10:00 p.m.	A & B	Portage Hotel
Toledo	Wed., May 17	7:00 p.m. to 10:00 p.m.	A & B	Commodore Perry Hotel
Pennsylvania:				
Pittsburgh	Wed., April 25	7:00 p.m. to 10:00 p.m.	A & B	Hotel William Penn
Philadelphia	Wed., June 6	7:00 p.m. to 10:00 p.m.	A & B	Adelphia Hotel
Michigan:				
Detroit	Sun., May 20	1:00 p.m. to 5:00 p.m.	A & B	Hotel Statler
New York:				
Buffalo	Tue., May 22	7:00 p.m. to 10:00 p.m.	A & B	Hotel Statler
Syracuse	Wed., May 23	7:00 p.m. to 10:00 p.m.	A & B	Hotel Syracuse
Rochester	Thur., May 24	7:00 p.m. to 10:00 p.m.	A & B	The Sheraton Hotel
New York	Thur., June 7	1:00 p.m. to 5:00 p.m.	A & B	Hotel Roosevelt
Maryland:				
Baltimore	Sun., June 3	1:00 p.m. to 5:00 p.m.	A & B	Lord Baltimore Hotel
District of Columbia:				
Washington	Sun., June 3	1:00 p.m. to 5:00 p.m.	A & B	Hotel Statler
Virginia:				
Richmond	Mon., June 4	7:00 p.m. to 10:00 p.m.	A & B	Hotel John Marshall
Norfolk	Mon., June 4	7:00 p.m. to 10:00 p.m.	A & B	Commodore Moury Hotel
New Jersey:				
Newark	Thur., June 7	1:00 p.m. to 5:00 p.m.	A & B	The Douglas Hotel
Connecticut:				
Hartford	Sun., June 10	7:00 p.m. to 10:00 p.m.	A & B	Hotel Statler
Massachusetts:				
Boston	Sun., June 10	7:00 p.m. to 10:00 p.m.	A & B	Hotel Statler

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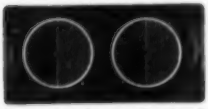

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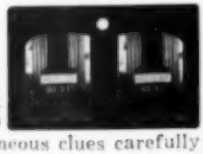

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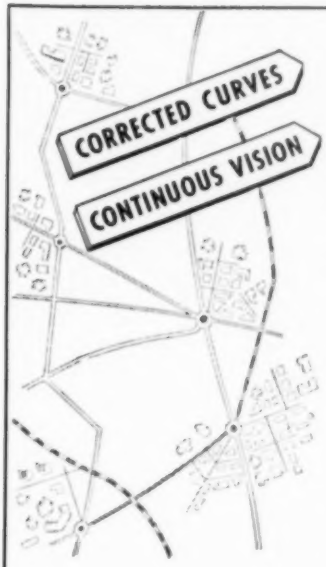

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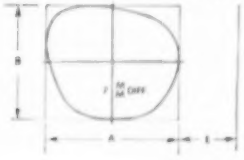
EYE	A	B	E BRIDGE
40	41.5	34.5	18 20 22
42	43.5	36.5	18 20 22 24
44	45.5	38.5	18 20 22 24
46	47.5	40.5	18 20 22 24

P.D. = A + E 43.5 + 20 = 63.5 P.D.



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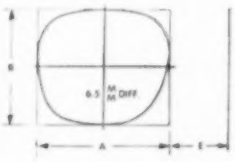
46	47	40.5	20 22 24
48	49	42.5	20 22 24

P.D. = A + E 43 + 20 = 63 P.D.



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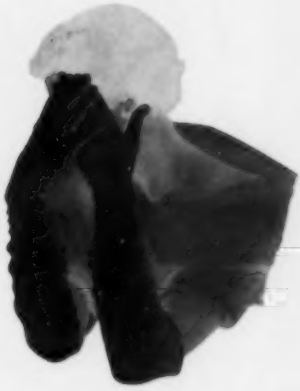

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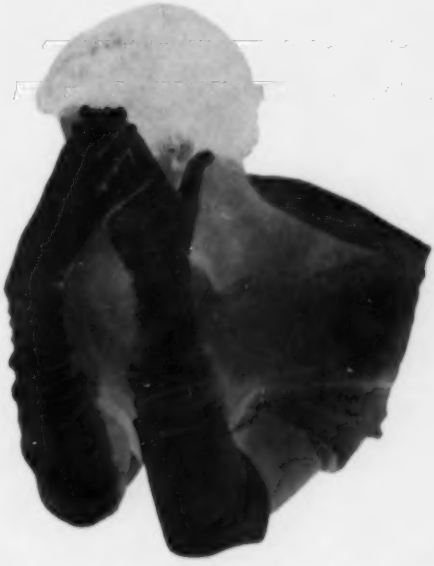

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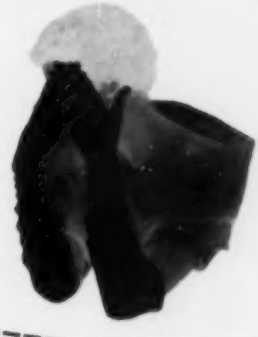

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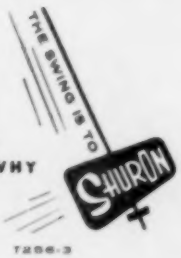

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